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RESEARCH MEMORANDUM

THE EFFECTS OF OPERATING PROPELLERS ON THE LONGITUDINAL CHARACTERISTICS AT HIGH SUBSONIC SPEEDS OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10

By Fred B. Sutton and Fred A. Demele

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Moffett Field, Calif.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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THE EFFECTS OF OPERATING PROPELLERS ON THE LONGITUDINAL CHARACTERISTICS AT HIGH SUBSONIC SPEEDS OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10

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SUMMARY

An investigation has been conducted at high subsonic speeds to determine the effects of operating propellers on the longitudinal characteristics of a four-engine tractor airplane configuration having a 40° swept wing with an aspect ratio of 10. Wind-tunnel tests were conducted through ranges of angles of attack and propeller thrust coefficients at Mach numbers from 0.60 to 0.90 at Reynolds numbers of 1,000,000 and 2,000,000. The effects of varying propeller blade angle, tail incidence, and vertical height of the horizontal tail were investigated.

The over-all effects of operating propellers on the longitudinal characteristics were not large when compared to the effects of propeller operation at low speed. Compared to the model with the propellers off, operation of the propellers at constant thrust coefficients generally decreased the static longitudinal stability. Increasing the propeller thrust coefficient at a constant Mach number increased both the static longitudinal stability and the trimmed lift coefficient. Operation of the propellers at constant thrust coefficient increased the wing lift-curve slope but had little effect on the variation of lift-curve slope with Mach number. Operation of the propellers had little effect on the Mach number for longitudinal force divergence at a constant lift coefficient but resulted in a decrease in the rate of change of longitudinal force coefficient with Mach number at supercritical speeds. This effect increased with increasing propeller thrust coefficient and with increasing lift coefficient.

A method of predicting the effects of propeller normal force on the pitching-moment characteristics of the configuration is presented. Comparisons with measured effects indicate that the accuracy of the method is good.

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Raising the horizontal tail had little effect on the longitudinal stability with the propellers removed but was destabilizing with the propellers operating.

For an assumed airplane, operating at the power required for level flight at an altitude of 40,000 feet, calculations indicate only a small change in the stable variation of tail incidence for trim with Mach number compared to the propellers-off condition.

INTRODUCTION

The potentialities of turbine-propeller propulsion systems are well recognized, particularly with regard to the take-off and range capabilities of multiengine airplanes. The combination of a turbine-propeller propulsion system and an airframe configuration utilizing a sweptback wing of high aspect ratio should make possible the achievement of long-range flight at relatively high subsonic speeds. This propulsive system could utilize supersonic propellers with high disc loadings. It is not believed that the effects of these propellers on the longitudinal characteristics of swept wings can be adequately predicted, either by existing theoretical methods or by available experimental data.

An investigation has been made in the Ames 12-foot pressure wind tunnel to determine the longitudinal characteristics of a representative multiengine airplane configuration with sweptback wings of high aspect ratio. The investigation was made with and without operating supersonic propellers. The power-off longitudinal characteristics of several combinations of the components of this configuration have been presented in references 1 to 4. The characteristics of the propeller are reported in reference 5. The results of a low-speed investigation to determine the effects of operating propellers on the longitudinal characteristics are presented in reference 6. The present report is concerned with the effects of operating propellers on the longitudinal characteristics of the configuration at high subsonic speeds. Tests were conducted over a Mach number range of 0.60 to 0.90 at Reynolds numbers of 1,000,000 and 2,000,000. If the model is assumed to be 1/12 scale, the power conditions simulated at most test Mach numbers varied from windmilling to 5000 horsepower per engine at an altitude of 40,000 feet or to 20,000 horsepower per engine at sea level.

NOTATION

A_{av}	upflow angle, average angle of local flow at the 0.7 propeller radius and at the horizontal center line of the propeller plane, measured with respect to the thrust axis in a plane parallel to the plane of symmetry
a	mean-line designation, fraction of chord over which the design load is uniform
a'	normal acceleration
$\frac{b}{2}$	wing semispan perpendicular to the plane of symmetry
b'	propeller blade width
C_L	lift coefficient, $\frac{\text{lift}}{qS}$
C_{L_t}	tail lift coefficient, $\frac{\text{tail lift}}{qS_t}$
C_m	pitching-moment coefficient referred to the center of gravity, $\frac{\text{pitching moment}}{qS\bar{c}}$ (See fig. 1(a).)
C_N	propeller normal-force coefficient, $\frac{N}{qS}$
C_P	power coefficient, $\frac{P}{\rho n^3 D^5}$
C_T	thrust coefficient per propeller, $\frac{T}{\rho n^2 D^4}$
C_X	longitudinal force coefficient, $\frac{X}{qS}$
c	local wing chord parallel to the plane of symmetry
c'	local wing chord normal to the reference sweep line (See table I.)

$\bar{c}$	wing mean aerodynamic chord, $\dfrac{\int_0^{b/2} c^2 dy}{\int_0^{b/2} c\, dy}$
c_{l_i}	wing-section design lift coefficient
c.g.	center-of-gravity location (See fig. 1(a).)
g	acceleration due to gravity
D	propeller diameter
h	maximum thickness of propeller blade section
hp	horsepower per engine
i_t	incidence of the horizontal tail with respect to the wing-root chord
J	propeller advance ratio, $\dfrac{V}{nD}$
l_t	tail length, distance between the quarter points of the mean aerodynamic chords of the wing and of the horizontal tail measured parallel to the plane of symmetry
M	free-stream Mach number
N	normal force per propeller
n	propeller rotational speed
n'	normal acceleration factor, $\dfrac{a'}{g}$
P	shaft power per motor
q	free-stream dynamic pressure, $\dfrac{1}{2}\rho V^2$
R	Reynolds number, based on the wing mean aerodynamic chord
R'	propeller-tip radius
r	propeller-blade-section radius

S	area of semispan wing
S_t	area of semispan tail
T	thrust per propeller parallel to the stream
T_c	thrust coefficient per propeller, $\frac{T}{\rho V^2 D^2}$
t	wing section maximum thickness
V	free-stream velocity
W	weight of assumed full-scale airplane
X	longitudinal force, parallel to stream and positive in a dragwise direction
y	lateral distance from the plane of symmetry
α	angle of attack of the wing chord at the plane of symmetry referred to herein as the wing-root chord
α_t	angle of attack of the tail
β	propeller blade angle measured at 0.70 tip radius
β'	propeller-blade-section angle
ϵ	effective downwash angle
η	propeller or propulsive efficiency, $\frac{C_T J}{C_P}$
ρ	mass density of air
φ	angle of local wing chord relative to the wing-root chord, positive for washin, measured in planes parallel to the plane of symmetry
$\eta_t\left(\frac{q_t}{q}\right)$	tail efficiency factor (ratio of the lift-curve slope of the horizontal tail when mounted on the fuselage in the flow field of the wing to the lift-curve slope of the isolated horizontal tail)
$\frac{\partial C_m}{\partial i_t}$	tail effectiveness parameter, measured for a given angle of attack

Subscripts

av average

w wing

t tail

MODEL AND APPARATUS

The semispan model represented the right-hand side of a hypothetical four-engine airplane. Figures 1(a) through 1(d) and table I present dimensions and details of the model. Figure 2 shows the model mounted in the wind tunnel. The selection of the geometric properties and the details of the construction of the wing, nacelles, fences, tail, and fuselage have been discussed in references 1, 2, and 3. The three-bladed supersonic propeller, designated NACA 1.167-(0)(03)-058 and having right-hand rotation, was specifically designed for the subject investigation and is described in detail in reference 5. Figure 3 presents the propeller plan-form and blade-form curves.

The power to drive the propellers was supplied by a variable-speed induction motor in each nacelle. Each motor had a normal rating of 75 horsepower at 18,000 revolutions per minute. The propellers were driven through gears at a rotational speed 1.5 times that of the motors. The shaft power delivered to the propellers was determined by measuring the input power to the motors and applying corrections for the motor and gearbox losses. Motor rotational speed was measured by means of an electronic tachometer on each motor.

TESTS

Test Conditions

The longitudinal characteristics of the model were investigated over a Mach number range of 0.60 to 0.90 at Reynolds numbers of 1,000,000 and 2,000,000. At each Mach number, tests were made with propeller blade angles of 41° and 51° through an angle-of-attack range of 2° to 10°. At each angle of attack, the propeller rotational speed was varied from windmilling to the maximum obtainable, being limited by either maximum motor speed or maximum motor power. Measurements of the static pressures on the wind-tunnel walls during the tests at a Mach number of 0.90

indicated the possibility of partial choking of the wind tunnel. It is believed that the force and moment data shown at this Mach number are partially affected by this phenomenon.

Tests were made at tail heights of 0 b/2 and 0.10 b/2 above the fuselage center line. Tail incidences of -2°, -4°, and -6° were investigated at the 0 b/2 tail position.

Propeller Calibration

The propeller was calibrated on a specially constructed calibration nacelle which allowed the characteristics of the propeller, in the presence of the spinner and the nacelle forebody to be ascertained. Reference 5 presents the details of the calibration procedure and the results of the calibration. Propeller normal-force characteristics were determined as part of the propeller calibration and are presented herein.

REDUCTION OF DATA

Thrust Coefficient

The model thrust coefficient, T_c, used herein is the average for the two propellers, and is obtained from the results of the propeller calibration (ref. 5). Advance ratios were computed for each of the propellers, and the corresponding thrust coefficients were obtained from the calibration results at a comparable Mach number, Reynolds number, average propeller upflow angle (ref. 7), and propeller blade angle. Typical variations of thrust coefficient with advance ratio for one propeller (ref. 5) are shown in figure 4.

Adjustment to the advance ratios of the propellers operating on the model was necessary since propeller blade angles could be duplicated only to within $\pm 0.15^\circ$ between the propeller calibration and the present test. In addition, it is probable that differences in the effective propeller blade angles between the model and the calibration nacelle existed because of slightly dissimilar radial distribution of upflow in the plane of the propeller (ref. 7). The adjustment used was based on the observed differences in windmilling advance ratios between propeller operation on the model and on the calibration nacelle at comparable geometric propeller blade angles and test conditions. It was assumed that thrust as well as power was approximately equal at the windmilling advance ratios for the two operations and that the small blade-angle difference did not affect the rate of change of thrust coefficient with advance ratio. Advance ratios measured for the propellers operating on

the model were adjusted by the difference between the windmilling advance ratios measured for the propeller operating on the model and on the calibration nacelle. Thrust coefficients for the powered model were then obtained from the calibration results at these adjusted advance ratios. These effects were generally small and changed the propeller thrust coefficient by only 0.002 at the higher Mach numbers and the larger thrust coefficients.

Force and Moment Data

The basic data obtained at various thrust coefficients at constant angle of attack were reduced to conventional form and are presented as lift coefficient as a function of angle of attack, and longitudinal force coefficient and pitching-moment coefficient as functions of lift coefficient. These variations with angle of attack and lift coefficient were obtained by cross plotting the basic data for a lift-coefficient and thrust-coefficient relationship corresponding to an assumed full-scale power condition (fig. 5) and for constant thrust coefficient.

Corrections

The data have been corrected for constriction effects due to the presence of the tunnel walls, for tunnel-wall interference originating from lift on the wing, and for longitudinal force tares caused by aerodynamic forces on the exposed portion of the turntable upon which the model was mounted.

The effects of wind-tunnel-wall constraint on the propeller slipstreams were evaluated by the method of references 8 and 9 and were found to be negligible. The dynamic pressure was corrected for constriction effects due to the presence of the tunnel walls by the method of reference 10. These corrections and the corresponding corrections to the Mach number are listed in the following table:

Corrected Mach number	Uncorrected Mach number	$\frac{q_{Corrected}}{q_{Uncorrected}}$
0.60	0.598	1.006
.70	.695	1.009
.80	.793	1.011
.83	.821	1.013
.86	.848	1.014
.90	.883	1.022

Corrections for the effects of tunnel-wall interference originating from the lift on the wing were calculated by the method of reference 11. The corrections to the angle of attack and to the longitudinal force coefficient showed insignificant variations with Mach number. The corrections added to the data were as follows:

$$\Delta\alpha = 0.38\ C_L$$

$$\Delta C_X = 0.0059\ {C_L}^2$$

The correction to the pitching-moment coefficient had significant variations with Mach number. The following corrections were added to the pitching-moment coefficients:

$$\Delta C_m = K_1\ C_{L_{tail\ off}} \qquad \text{(Tail off)}$$

$$\Delta C_m = K_1\ C_{L_{tail\ off}} - \left[\left(K_2\ C_{L_{tail\ off}} - \Delta\alpha\right)\frac{\partial C_m}{\partial i_t}\right] \qquad \text{(Tail on)}$$

The values of K_1 and K_2 for each Mach number were calculated by the method of reference 11 and are given in the following table:

M	K_1	K_2
0.60	0.0048	0.77
.70	.0057	.79
.80	.0069	.81
.83	.0073	.82
.86	.0078	.83
.90	.0087	.85

The correction constants for the tunnel-wall interference effects were computed for propeller-off conditions since the effects of propeller slipstream on wing lift and tail effectiveness were small over the Mach number range of the investigation. However, the lift coefficients used to determine the actual corrections were total values reflecting all the propeller effects. Results of the propeller calibration indicated the effects of propeller direct forces to be negligible.

Since the turntable upon which the model was mounted was directly connected to the balance system, a tare correction to longitudinal force was necessary. This correction was determined by multiplying the

longitudinal force on the turntable, as determined from tests with the model removed from the wind tunnel, by the fraction of the turntable area not covered by the model fuselage. The following corrections were subtracted from the measured longitudinal force coefficients:

M	$C_{X_{tare}}$
0.60	0.0025
.70	.0026
.80	.0028
.86	.0030
.90	.0032

No attempt has been made to evaluate tares due to interference between the model and the turntable or to compensate for the tunnel-floor boundary layer which, at the turntable, had a displacement thickness of one-half inch.

RESULTS AND DISCUSSION

An index to the basic data is presented in table II. The basic data are tabulated in tables III through XI, and the coefficients of lift, longitudinal force, and pitching moment are plotted in conventional form for constant values of thrust coefficient in figures 6 to 14. Figures 15 through 31 present, for selected conditions, the effects of propeller operation, Mach number, tail height, Reynolds number, and propeller blade angle on the longitudinal characteristics of the model.

Effects of Operating Propellers on the Longitudinal Characteristics

The longitudinal characteristics of the model, with and without operating propellers, are presented in figures 6 through 14. In general, the effects of the operating propellers were not large compared to the propeller effects at low speed shown in reference 6. Compared to the model without propellers, operation of the propellers at constant thrust coefficients generally increased the lift-curve slopes and decreased the static longitudinal stability. The term "static longitudinal stability," as used herein, refers to the slopes of the curves of pitching-moment coefficient as a function of lift coefficient. Decreases in stability are indicated by reductions in the negative slopes of the curves. Generally, the trim lift coefficients increased with increasing thrust coefficient but at any constant thrust coefficient they decreased with increasing Mach number. There was no large effect of operating propellers on the variation of longitudinal force coefficient with lift

coefficient at lift coefficients less than about 0.40 or 0.50. It is believed that the erratic variations shown in some of the longitudinal force data at a Mach number of 0.90 are due, at least in part, to the choking phenomenon previously mentioned.

The variations of the longitudinal characteristics with Mach number are presented in figures 15, 16, and 17. These variations are shown at lift coefficients of 0.20 and 0.40 for the model with the propellers off and with the propellers operating at several constant values of thrust coefficient.

Operation of the propellers increased the lift-curve slopes (fig. 15) but, in general, had only small effects on the variation of lift-curve slope with Mach number. At a lift coefficient of 0.40, operating the propellers at a thrust coefficient of 0.03 increased the Mach number for lift divergence from approximately 0.83 to approximately 0.86.

Figure 16 shows the variation with Mach number of the increment of longitudinal force coefficient above its value at a Mach number of 0.70 for several different values of propeller thrust coefficient and with propellers removed. It was anticipated that the Mach number of longitudinal force divergence would be decreased as a result of the increased velocity behind the operating propellers. However, this effect did not occur, and the Mach number for drag divergence was little affected by operation of the propellers. At supercritical speeds, the drag rise with increasing Mach number was reduced considerably with increase in propeller thrust coefficient. This reduction was due, in part, to increases in the wing lift-curve slope with the propellers operating. Thus, the same lift coefficient can be obtained at a lower angle of attack and this fact tended to reduce the shock-induced losses over the outer portion of the wing span. It is also thought that some of the effect stemmed from increases in the effective Reynolds numbers of the wing sections immersed in the propeller slipstreams. It is doubtful that a favorable Reynolds number phenomenon would prevail at full-scale Reynolds numbers.

The effects of Mach number on the slopes of the pitching-moment curves are presented in figure 17 at lift coefficients of 0.20 and 0.40 for the model with the propellers off and with the propellers operating at several constant values of thrust coefficient. The effects of Mach number were generally greater with the propellers operating than with the propellers off. In general, the static longitudinal stability decreased slightly with Mach number when the tail was on and increased slightly when the tail was off up to a Mach number of approximately 0.82. At higher speeds, changes in stability due to Mach number were inconsistent and more pronounced.

Effects of the Operating Propellers on the Longitudinal Stability

The factors which determine the static longitudinal stability of a propeller-driven airplane are the stability with the propellers removed, the direct propeller forces normal to and along the thrust axis, and the effects of the propeller slipstream on the flow on the wing and at the horizontal tail. Figures 18 and 19 show for several Mach numbers these various effects of the operating propellers on tail-on and tail-off static longitudinal stability at zero thrust, at a comparatively high constant thrust coefficient, and at the conditions of constant horsepower shown in figure 5. The data presented were obtained by adding pitching-moment increments, referred to the center of gravity, due to propeller thrust and normal force (from the propeller calibration data) to the propellers-off pitching-moment data. This total was then subtracted from the power-on pitching moments to ascertain approximately the slipstream effects. For both constant thrust and constant power, the various effects of the operating propellers on the pitching-moment characteristics of the model were small. For the center-of-gravity position shown on figure 1(a), normal force and thrust of the propellers were generally destabilizing. The effects of the propeller slipstream on the wing were generally destabilizing while their effects on the tail were generally stabilizing.

Figure 20 presents, for a Mach number of 0.80 and a constant thrust coefficient of 0.04, a comparison of the predicted and measured variations with angle of attack of the incremental pitching-moment coefficient due to propeller normal force. The measured variations of increments of pitching-moment coefficient with angle of attack due to propeller thrust and propeller slipstream on the wing and tail are also shown. The effect of propeller normal force on the pitching moment was calculated by the method presented in the Appendix. The predicted pitching-moment increments due to the propeller normal force are in good agreement with the measured effects. The small discrepancy at the lower angles of attack is believed due to lift stemming from the asymmetry of the nacelle forebody. The theoretical computations did not account for any lift contribution due to the nacelle forebody.

The effects of propeller slipstream on the pitching-moment characteristics of the wing and tail could not be predicted to any acceptable degree of accuracy with existing methods. It is believed that the combination of the effects of wing sweepback, of viscous separation, of propeller slipstream rotation, and of wing-nacelle interference makes the estimation of slipstream effects on the pitching-moment characteristics of the wing and tail virtually impossible for the present model.

Figure 21 shows the variation with Mach number of the various effects of the operating propellers on the pitching-moment-curve

slopes $\Delta(dC_m/dC_L)$. The data are presented for a representative lift coefficient for level flight ($C_L = 0.40$) and for constant thrust coefficient and constant simulated horsepower. The effects of slipstream on the horizontal tail were assumed to be the differences between tail-on and tail-off slipstream effects. The effect of propeller normal force varied with Mach number at constant horsepower because of the relationship of thrust coefficient and lift coefficient used in calculating the conditions (fig. 5). The variations of the effects of the propeller slipstream with Mach number were small, generally amounting to a change in pitching-moment-curve slope of less than ±0.05.

Effects of the Operating Propellers on the Stability Contribution of the Horizontal Tail

The horizontal-tail contribution to stability is a function of the downwash factor $1 - (\partial\epsilon/\partial\alpha)$, the tail-efficiency factor $\eta_t(q_t/q)$, and the ratio $\frac{(dC_{L_t}/d\alpha_t)_{\text{isolated tail}}}{(dC_L/d\alpha)_{\text{tail off}}}$. Calculations were made using the method of reference 12 to evaluate the effective downwash characteristics and the tail efficiency factor with and without operating propellers. The force data presented in figures 6 through 9 and the isolated tail-force data presented in reference 3 were used for the computations of effective downwash angle ϵ, $\eta_t(q_t/q)$, and the ratio $\frac{(dC_{L_t}/d\alpha_t)_{\text{isolated tail}}}{(dC_L/d\alpha)_{\text{tail off}}}$ and the results are shown for several Mach numbers in figures 22, 23, and 24 as functions of angle of attack. It was assumed for the computation of downwash angle ϵ and tail-efficiency factor $\eta_t(q_t/q)$ that the Mach number at the tail was the same as the free-stream Mach number. The effect of the propellers on downwash amounted to a change in downwash angle of 0.5° or less. At high angles of attack the effect of the operating propellers on the factors $\eta_t(q_t/q)$ and $\frac{(dC_{L_t}/d\alpha_t)_{\text{isolated tail}}}{(dC_L/d\alpha)_{\text{tail off}}}$ was sizable, however, these effects are compensating and their over-all effect on tail effectiveness was small.

The variations with Mach number of the tail-effectiveness parameter, $\partial C_m/\partial i_t$, the isolated tail lift-curve slope, and the various factors affecting the stability contribution of the tail are shown in figures 25, 26, and 27 for a representative level flight, high-speed altitude ($\alpha=4^\circ$). The effects of Mach number on $\partial C_m/\partial i_t$ were small with and without the

operating propellers. For the selected condition, operation of the propellers had little effect on the variations of the factors $1 - (\partial\epsilon/\partial\alpha)$, $\eta_t(q_t/q)$, and $\dfrac{(dC_{L_t}/d\alpha_t)_{\text{isolated tail}}}{(dC_L/d\alpha)_{\text{tail off}}}$ with Mach number.

The effects of horizontal-tail height on the pitching-moment-curve slopes of the model with and without operating propellers are shown in figure 28 for several Mach numbers. Raising the horizontal tail increased the static longitudinal stability slightly with the propellers off at Mach numbers less than 0.90, but was destabilizing over the Mach number range of the investigation with the propellers operating.

Propulsive Characteristics

Figure 29 presents for an upflow angle of approximately 0° and a Mach number of 0.80, a comparison of the characteristics of the isolated propeller (ref. 5) with the propulsive characteristics of the model. Also shown is a comparison of the variations with Mach number of the efficiency of the isolated propeller and the propulsive efficiency of the model at a constant thrust coefficient of 0.04.

The propulsive characteristics include the lift due to the propeller slipstream (ref. 13) and the effects of the operating propellers on longitudinal force characteristics previously discussed. The propeller is credited with these effects by calculating the effective thrust coefficients and propulsive efficiencies of the model as follows:

$$C_{T_{\text{effective}}} = -(S/4D^2)\, J^2 \left(C_{X_{\text{props on}}} - C_{X_{\text{props off}}}\right)_{\text{const.}\, C_{L_{\text{props on}}}}$$

and propulsive efficiency

$$\eta = \frac{C_{T_{\text{effective}}}\, J}{C_P}$$

Figure 29 indicates that the effective thrust coefficients for the conditions selected for the comparison were greater than the thrust coefficients measured for the isolated propeller, and that the corresponding propulsive efficiencies, consequently, exceeded the efficiencies indicated for the isolated propeller. Generally, the propulsive efficiency increased with increasing Mach number while the efficiency of the isolated propellers decreased slightly. This effect is

believed to be associated with the decrease in the rate of change of longitudinal force coefficient with Mach number indicated in figure 16.

In computing propulsive efficiencies, no distinction was made between the effects of propeller slipstream and the effects of propeller direct forces. However, for the range of Mach numbers and propeller thrust coefficients of the subject investigation, the effects of propeller direct forces on lift were negligible.

Longitudinal Characteristics of an Assumed Airplane

Figure 30 presents a summation of the longitudinal characteristics, as calculated from the results of the subject investigation, of an assumed airplane operating with the power required for level flight at an altitude of 40,000 feet. These characteristics are presented as functions of Mach number or normal-acceleration factor. The lift coefficients shown are computed values based on a wing loading of 65 pounds per square foot and the assumed airplane altitude.

The effects of propeller operation at the power for level flight on the static longitudinal stability of the airplane were small (fig. 28). Compared to propellers-off stability a maximum decrease in pitching-moment-curve slope of 0.04 was indicated at a Mach number of 0.70. Only a small change was indicated in the stable variation of tail incidence for trim with Mach number between the conditions of propellers off and propellers operating at the power required for level flight. At constant Mach number, the variation of tail incidence for trim with normal acceleration was not greatly affected by the operation of the propellers at the power required for level flight.

Effects of Reynolds Number and Propeller Blade Angle

Lift-curve slopes, pitching-moment-curve slopes, and longitudinal force coefficients for the model at a lift coefficient of 0.40, with and without operating propellers, are presented in figure 31 for Reynolds numbers of 1,000,000 and 2,000,000 at Mach numbers of 0.70, 0.80, and 0.90. These slopes and coefficients are also presented for propeller blade angles of 41° and 51° at Mach numbers of 0.70 and 0.80. The effects of varying Reynolds number and propeller blade angle on the lift-curve slopes and pitching-moment-curve slopes were negligible at Mach numbers of 0.70 and 0.80. Appreciable Reynolds number effects were evident on these slopes at a Mach number of 0.90. However, it is believed that the data for this Mach number were affected by the partial choking previously mentioned.

Longitudinal force coefficients were only slightly affected by changes of Reynolds number and of propeller blade angle at a Mach number of 0.70 and 0.80. At a Mach number of 0.90, increasing the Reynolds number from 1,000,000 to 2,000,000 resulted in sizable decreases in longitudinal force coefficient.

CONCLUSIONS

An investigation has been made of the effects of operating propellers upon the longitudinal characteristics of a four-engine tractor airplane configuration employing a wing with 40° of sweepback and an aspect ratio of 10. The Mach number range of the investigation was 0.60 to 0.90. The following conclusions were indicated:

1. The over-all effects of operating propellers on the longitudinal characteristics at high subsonic speeds were not large when compared to the effects of operating propellers at low speeds. The propellers operating at constant thrust coefficients generally resulted in a reduction in the longitudinal stability. Increasing the propeller thrust coefficient while maintaining a constant Mach number increased both the longitudinal stability and the trimmed lift coefficient.

2. Operation of the propellers at constant thrust coefficient increased the wing lift-curve slope but had little effect on the variation of lift-curve slope with Mach number.

3. Operation of the propellers had little effect on the Mach number for longitudinal force divergence at a constant lift coefficient but resulted in a decrease in the rate of change of longitudinal force coefficient with Mach number at supercritical speeds. This effect increased with increasing propeller thrust coefficient and with increasing lift coefficient.

4. It was possible to predict the effects of propeller normal force on the longitudinal stability of the model with good accuracy. However, the propeller slipstream effects on the wing and horizontal tail could not be predicted with existing methods to any acceptable degree of accuracy.

5. Raising the horizontal tail had little effect on the longitudinal stability with the propellers removed but was destabilizing with the propellers operating.

6. For an assumed airplane, operating at the power required for level flight at an altitude of 40,000 feet, calculations indicate only

a small change in the stable variation of tail incidence for trim with either Mach number or normal acceleration compared to the propellers-off condition.

Ames Aeronautical Laboratory
National Advisory Committee for Aeronautics
Moffett Field, Calif., Oct. 23, 1953

APPENDIX

CALCULATION OF PROPELLER NORMAL FORCE

Isolation of propeller effects on the longitudinal stability of an airplane requires either a knowledge of the normal-force characteristics of the propeller or a suitable method of calculating those characteristics. The method used herein for predicting propeller normal force is presented in this Appendix in addition to experimental normal-force data obtained with the calibration nacelle reported in reference 5.

Presented in figure 32 is propeller normal-force coefficient as a function of upflow angle at 0.7 propeller radius for the NACA 1.167-(0)(03)-058 three-blade propeller used in this investigation. Shown in figure 33 for a representative blade angle and Mach number at an upflow angle of 5° is a comparison of the experimental and theoretical variation of normal-force-curve slope with thrust coefficient. It may be noted that the agreement between the theoretical and experimental slopes is good, the theoretical values being approximately 95 percent of the experimental normal-force-curve slopes.

The method used in calculating propeller normal force, which was proposed by Messrs. Vernon L. Rogallo and John L. McCloud III of the Ames Aeronautical Laboratory, is based on the relationship of the propeller normal force to the oscillating torque-producing components of force on the blades as they operate in the nonuniform flow field. This can be expressed as follows:

$$C_N = \frac{4}{\pi J^2} \sum_{x=x_s}^{x=1.0} \left(c_{f_1} \cos \omega_{f_1}\right)_x$$

where

C_N normal-force coefficient, $\frac{4N}{q\pi D^2}$

D propeller diameter, ft

J advance ratio, $\frac{V}{nD}$

c_{f_1} amplitude of $1 \times P$ variation of torque-force coefficient

N normal force, measured perpendicular to thrust axis, lb

x radial location of blade section, $\frac{r}{R}$

X_s spinner radius, fraction of tip radius

ω_{f_1} phase angle of $1 \times P$ variation of torque force

If it is assumed that there are no odd-order variations of torque force above the fundamental, the product $(c_{f_1} \cos \omega_{f_1})$ can be found by the following relationship:

$$(c_{f_1} \cos \omega f_1)_x = 1/2 \left(c_{f_{\Omega=90^\circ}} - c_{f_{\Omega=270^\circ}} \right)_x$$

where

Ω angular position about the thrust axis, measured counterclockwise from the upper vertical position as seen from the front, deg

The torque force coefficient can be calculated by its relationship to the thrust coefficient, that is,

$$c_f = c_t \tan (\varphi + \gamma)$$

The formula for computing the thrust coefficient is the same as given in reference 14, except that ψ is replaced by $\pm A$ and is as follows:

$$c_{t_{\Omega=90,\ 270^\circ}} = K\pi^3 X^3 \frac{\alpha_1}{57.3} \frac{\cot \varphi - \tan \gamma}{\left(\cot \varphi + \frac{\alpha_1}{57.3} \right)^2} \left(1 \pm \frac{V' \sin A}{\pi nDX} \right)^2$$

where

A upflow angle, angle of local flow at 0.7 propeller radius and at the horizontal center line of the propeller, measured with respect to the thrust axis in a plane parallel to the plane of symmetry, deg

c_t section thrust coefficient, $\frac{\text{thrust}}{\rho n^2 D^4}$

K Goldstein correction factor for finite number of blades

r radius to blade section, ft

R' propeller radius, ft

[redacted]

α_i propeller induced angle of inflow, deg

γ $\tan^{-1}\left(\frac{\text{blade-section drag}}{\text{blade-section lift}}\right)$

φ $\varphi_o + \alpha_i$, deg

φ_o $\tan^{-1}\left(\frac{V' \cos A}{\pi nDX \pm V' \sin A}\right)$

V' local velocity, ft/sec

and where both + and - signs are indicated, the + is for $\Omega = 90^\circ$, and the - is for $\Omega = 270^\circ$.

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TABLE I.- GEOMETRIC PROPERTIES OF THE MODEL

Wing	
Reference sweep line: Locus of the quarter-chord points of sections inclined 40° to the plane of symmetry	
Aspect ratio (full-span wing)	10.0
Taper ratio	0.4
Sweepback	40°
Twist	-5°
Reference sections (normal to reference sweep line)	
Root	NACA 0014, a=0.8 (modified) c_{l_i}=0.4
Tip	NACA 0011, a=0.8 (modified) c_{l_i}=0.4
Area (semispan model)	6.944 ft²
Mean aerodynamic chord	1.251 ft
Incidence (measured in the plane of symmetry)	3°
Fences at $y/b/2$ = 0.33, 0.50, 0.70, and 0.85 (See fig. 1(d) for fence details.)	
Nacelles	
Frontal area (each)	0.208 ft²
Inclination (measured with respect to wing root chord)	
Inboard	-6.5°
Outboard	-7.0°
Propellers	
Diameter	1.167 ft
Number of blades	3
Propeller-activity factor (per blade)	188.4
Propeller-blade thickness-chord ratio (0.70 radius)	0.03
Solidity (per blade)	0.058
Blade sections	Symmetrical NACA 16 series
Horizontal Tail	
Reference sweep line: Locus of quarter-chord points of sections inclined 40° to the plane of symmetry	
Aspect ratio (full-span tail)	4.5
Taper ratio	0.4
Sweepback	40°
Reference section (normal to reference sweep line)	NACA 0010
Tail length, l_t	3.25 ft

[redacted]

TABLE I.- GEOMETRIC PROPERTIES OF THE MODEL - Concluded

Horizontal Tail (Continued)

Area (semispan model) . . . . $1.387\ ft^2$
Mean aerodynamic chord . . . . 0.833 ft
Tail volume, $l_t/c\ (S_t/S_w)$ 0.65
Tail heights (measured vertically from the fuselage center line to the hinge axis of the horizontal tail (see fig. 1(a)) 0, 0.10 b/2

Fuselage

Fineness ratio 12.6
Frontal area (semispan model) . . . . $0.273\ ft^2$
Fuselage coordinates:

Distance from nose, in.	Radius, in.
0	0
1.27	1.04
2.54	1.57
5.08	2.35
10.16	3.36
20.31	4.44
30.47	4.90
39.44	5.00
50.00	5.00
60.00	5.00
70.00	5.00
76.00	4.96
82.00	4.83
88.00	4.61
94.00	4.27
100.00	3.77
106.00	3.03
126.00	0

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TABLE II.- INDEX OF TABLES AND FIGURES REPRESENTING THE BASIC LONGITUDINAL DATA

Table	Figure	Tail height	i_t, deg	β, deg	R, million	M, range
III	6	$0 \frac{b}{2}$	-2	51	1	0.70 to 0.90
IV	7	$0 \frac{b}{2}$	-4	51	1	0.70 to 0.90
V	8	$0 \frac{b}{2}$	-6	51	1	0.70 to 0.90
VI	9	tail off	--	51	1	0.70 to 0.90
VII	10	$0.10 \frac{b}{2}$	-4	51	1	0.70 to 0.90
VIII	11	$0 \frac{b}{2}$	-4	51	2	0.70 to 0.90
IX	12	tail off	--	51	2	0.70 to 0.90
X	13	$0 \frac{b}{2}$	-4	41	2	0.60 to 0.80
XI	14	tail off	--	41	2	0.60 to 0.80

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TABLE III.- LONGITUDINAL CHARACTERISTICS OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10; TAIL HEIGHT = 0 b/2, $i_t = -2°$, $\beta = 51°$, R = 1,000,000

(a) M = 0.70, 0.80, 0.83

M, 0.70						
α	C_L	C_X	C_m	$T_{c_{SF}}$	J_{SF}	$C_{P_{SF}}$
[a]2.04	0.159	0.0216	-0.0218	---	---	---
2.04	.148	.0242	-.0343	-0.003	2.778	---
2.04	.147	.0139	-.0279	.009	2.555	0.251
2.03	.143	.0084	-.0176	.024	2.323	.413
2.03	.142	-.0103	-.0068	.041	2.121	.564
2.03	.141	-.0256	-.0013	.058	1.944	.655
[a]3.07	.259	.0222	-.0405	---	---	---
3.07	.254	.0249	-.0479	-.008	2.771	---
3.06	.251	.0144	-.0399	.010	2.589	.434
3.06	.251	.0031	-.0341	.024	2.389	.415
3.06	.252	-.0101	-.0288	.041	2.123	.568
3.07	.253	-.0226	-.0257	.057	1.945	.659
[a]4.10	.356	.0242	-.0777	---	---	---
4.09	.352	.0266	-.0682	-.008	2.774	---
4.09	.354	.0160	-.0558	.011	2.519	.241
4.10	.358	.0049	-.0516	.025	2.326	.423
4.10	.361	-.0089	-.0418	.042	2.126	.571
4.10	.365	-.0209	-.0438	-.057	1.950	.663
[a]5.12	.456	.0271	-.0767	---	---	---
5.12	.459	.0286	-.0768	-.008	2.774	---
5.12	.463	.0198	-.0722	.010	2.551	.287
5.12	.460	.0084	-.0676	.025	2.338	.418
5.13	.466	-.0036	-.0635	.043	2.137	.581
5.13	.471	-.0169	-.0589	.057	1.977	.668
[a]6.15	.556	.0313	-.0982	---	---	---
6.15	.551	.0340	-.0947	-.001	2.776	---
6.15	.556	.0241	-.0890	.011	2.586	.238
6.15	.563	.0126	-.0846	.027	2.382	.433
6.16	.571	.0006	-.0797	.043	2.121	.579
6.16	.578	-.0105	-.0758	.057	1.958	.665
[a]7.18	.648	.0383	-.1240	---	---	---
7.17	.646	.0409	-.1106	-.001	2.783	---
7.18	.653	.0316	-.1059	.012	2.556	.238
7.18	.662	.0207	-.1012	.026	2.337	.407
7.18	.672	.0098	-.0969	.044	2.186	.578
7.19	.680	-.0015	-.0925	.058	1.963	.654
[a]8.20	.737	.0714	-.1492	---	---	---
8.20	.740	.0506	-.1275	-.002	2.793	---
8.20	.747	.0402	-.1160	.013	2.536	.242
8.20	.754	.0300	-.1119	.026	2.338	.405
8.21	.764	.0203	-.1062	.044	2.127	.563
8.21	.772	.0113	-.1038	.059	1.983	.664
[a]9.21	.799	.0718	-.1639	---	---	---
9.22	.815	.0681	-.1382	-.001	2.793	---
9.22	.826	.0589	-.1271	.014	2.532	.261
9.22	.833	.0492	-.1218	.027	2.332	.434
9.23	.843	.0398	-.1149	.044	2.135	.588
9.23	.853	.0293	-.1100	.059	1.970	.669
[a]10.22	.851	.0946	-.1679	---	---	---
10.23	.862	.0988	-.1405	-.001	2.813	---
10.23	.866	.0887	-.1347	.015	2.543	.269
10.24	.896	.0784	-.1252	.027	2.387	.451
10.24	.908	.0688	-.1160	.044	2.133	.587
10.25	.919	.0538	-.1070	.058	1.978	.687

M, 0.80						
α	C_L	C_X	C_m	$T_{c_{SF}}$	J_{SF}	$C_{P_{SF}}$
[a]2.04	0.170	0.0250	-0.0280	---	---	---
2.04	.157	.0277	-.0387	-0.004	2.751	---
2.04	.157	.0185	-.0297	.007	2.538	0.199
2.04	.155	.0091	-.0207	.019	2.350	.357
2.04	.154	-.0029	-.0108	.034	2.139	.499
2.04	.153	-.0146	-.0045	.049	1.964	.594
[a]3.08	.279	.0251	-.0427	---	---	---
3.07	.271	.0283	-.0527	-.004	2.749	---
3.07	.271	.0196	-.0456	.007	2.549	.191
3.07	.272	.0098	-.0387	.019	2.354	.354
3.07	.273	-.0015	-.0314	.034	2.153	.498
3.07	.276	-.0129	-.0275	.048	1.974	.592
[a]4.11	.380	.0277	-.0582	---	---	---
4.10	.365	.0310	-.0777	-.004	2.743	---
4.10	.363	.0224	-.0769	.007	2.550	.187
4.11	.368	.0136	-.0531	.018	2.362	.349
4.11	.380	.0012	-.0493	.034	2.153	.500
4.11	.395	-.0097	-.0464	.047	1.985	.585
[a]5.14	.497	.0334	-.0772	---	---	---
5.14	.498	.0362	-.0787	-.004	2.748	---
5.14	.497	.0279	-.0751	.007	2.560	.183
5.14	.501	.0180	-.0721	.019	2.366	.338
5.14	.507	.0064	-.0690	.034	2.154	.508
5.14	.513	-.0048	-.0659	.049	1.980	.603
[a]6.16	.595	.0443	-.1008	---	---	---
6.17	.600	.0460	-.0951	-.003	2.758	---
6.17	.604	.0376	-.0930	.008	2.570	.182
6.17	.610	.0256	-.0908	.020	2.369	.360
6.17	.613	.0169	-.0871	.035	2.157	.506
6.17	.621	.0078	-.0856	.048	2.001	.608
[a]7.18	.673	.0595	-.1155	---	---	---
7.19	.690	.0606	-.1049	-.004	2.764	---
7.20	.698	.0525	-.1019	.007	2.574	.184
7.20	.702	.0429	-.1009	.020	2.374	.367
7.20	.706	.0330	-.0995	.035	2.163	.510
7.20	.713	.0244	-.0970	.046	2.004	.601
[a]8.19	.728	.0762	-.1018	---	---	---
8.20	.732	.0793	-.1050	-.004	2.778	---
8.21	.766	.0720	-.1041	.007	2.583	.193
8.21	.770	.0685	-.1007	.020	2.367	.368
8.21	.778	.0598	-.0991	.035	2.163	.527
8.22	.786	.0433	-.0997	.047	2.009	.606
[a]9.20	.778	.1000	-.1471	---	---	---
9.21	.808	.1000	-.1134	-.004	2.782	---
9.22	.828	.0920	-.1113	.006	2.573	.208
9.23	.837	.0841	-.1094	.018	2.379	.371
9.25	.839	.0760	-.1111	.033	2.170	.518
9.25	.843	.0666	-.1134	.046	2.001	.601
[a]10.21	.886	.1966	-.1748	---	---	---
10.22	.874	.1250	-.1281	-.004	2.794	---
10.23	.865	.1176	-.1308	.006	2.580	.210
10.23	.884	.1092	-.1241	.018	2.382	.375
10.24	.896	.0991	-.1180	.035	2.163	.551
10.24	.903	.0934	-.1178	.045	2.050	.604

M, 0.83						
α	C_L	C_X	C_m	$T_{c_{SF}}$	J_{SF}	$C_{P_{SF}}$
[a]2.04	0.173	0.0261	-0.0199	---	---	---
2.04	.165	.0295	-.0394	-0.004	2.745	---
2.04	.162	.0193	-.0308	.010	2.520	0.207
2.04	.160	.0091	-.0196	.021	2.311	.376
2.04	.159	-.0026	-.0085	.036	2.119	.495
2.04	.159	-.0138	-.0025	.049	1.917	.584
[a]3.08	.287	.0269	-.0403	---	---	---
3.08	.282	.0305	-.0539	-.003	2.786	---
3.08	.282	.0206	-.0432	.007	2.520	.206
3.08	.283	.0112	-.0368	.018	2.328	.361
3.08	.284	-.0006	-.0305	.033	2.125	.502
3.08	.286	-.0124	-.0275	.046	1.983	.588
[a]4.11	.402	.0306	-.0599	---	---	---
4.11	.399	.0343	-.0651	-.003	2.748	---
4.11	.402	.0242	-.0607	.008	2.524	.209
4.11	.405	.0145	-.0548	.020	2.329	.373
4.11	.411	.0042	-.0498	.034	2.135	.493
4.12	.416	-.0084	-.0470	.049	1.930	.587
[a]5.14	.508	.0399	-.0782	---	---	---
5.14	.511	.0421	-.0818	-.003	2.748	---
5.14	.514	.0324	-.0783	.008	2.525	.210
5.15	.520	.0229	-.0749	.020	2.331	.372
5.15	.526	.0133	-.0719	.034	2.140	.500
5.15	.533	.0008	-.0698	.048	1.941	.597
[a]6.16	.591	.0539	-.0928	---	---	---
6.17	.606	.0572	-.0929	-.003	2.735	---
6.17	.612	.0449	-.0920	.009	2.538	.185
6.17	.616	.0375	-.0889	.021	2.339	.371
6.17	.622	.0260	-.0857	.035	2.148	.503
6.18	.631	.0136	-.0842	.049	1.949	.599
[a]7.18	.660	.0692	-.0999	---	---	---
7.19	.682	.0724	-.0972	-.004	2.770	---
7.19	.689	.0689	-.0943	.009	2.536	.212
7.19	.681	.0541	-.0926	.021	2.336	.377
7.20	.699	.0436	-.0907	.036	2.147	.518
7.20	.709	.0344	-.0892	.048	1.963	.595
[a]8.19	.727	.0874	-.1133	---	---	---
8.20	.745	.0899	-.0975	-.004	2.767	---
8.21	.761	.0823	-.0985	.006	2.547	.213
8.21	.767	.0737	-.0979	.020	2.341	.381
8.21	.776	.0631	-.0971	.035	2.140	.527
8.21	.786	.0540	-.0982	.047	1.970	.597
[a]9.20	.774	.1096	-.1384	---	---	---
9.22	.805	.1187	-.1144	-.005	2.787	---
9.22	.825	.1033	-.1092	.006	2.546	.225
9.23	.841	.0978	-.1068	.020	2.335	.361
9.23	.845	.0860	-.1044	.035	2.150	.518
9.23	.857	.0778	-.1046	.047	1.982	.585
[a]10.21	.809	.1341	-.1777	---	---	---
10.22	.851	.1359	-.1276	-.003	2.802	---
10.23	.868	.1261	-.1266	.008	2.556	.233
10.24	.885	.1188	-.1221	.019	2.339	.386
10.23	.883	.1101	-.1275	.035	2.154	.526
10.24	.898	.1036	-.1334	.046	1.997	.596

[a]Props off.

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TABLE III.- LONGITUDINAL CHARACTERISTICS OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10; TAIL HEIGHT = 0 b/2, i_t = -2°, β = 51°, R = 1,000,000 - Concluded

(b) M = 0.86, 0.90

M, 0.86							M, 0.90						
α	C_L	C_X	C_m	$T_{c_{av.}}$	$J_{av.}$	$C_{P_{av.}}$	α	C_L	C_X	C_m	$T_{c_{av.}}$	$J_{av.}$	$C_{P_{av.}}$
a2.05	0.184	0.0286	-0.0186	- - -	- - -	- - -	a2.05	0.185	0.0388	-0.0138	- - -	- - -	- - -
2.05	.176	.0383	-.0414	-0.005	2.751	- - -	2.05	.192	.0485	-.0554	-0.005	2.721	- - -
2.04	.173	.0228	-.0300	.008	2.513	0.209	2.05	.189	.0268	-.0416	.009	2.486	0.238
2.04	.170	.0096	-.0164	.023	2.252	.402	2.05	.187	.0808	-.0516	.018	2.235	.351
2.04	.171	-.0005	-.0063	.035	2.061	.498	2.05	.186	.0106	-.0214	.027	2.037	.433
2.04	.170	-.0100	-.0003	.047	1.897	.573	2.05	.186	.0020	-.0187	.037	1.868	.462
a3.08	.303	.0318	-.0483	- - -	- - -	- - -	a3.08	.275	.0443	-.0547	- - -	- - -	- - -
3.08	.297	.0341	-.0554	-.005	2.756	- - -	3.08	.298	.0481	-.0772	-.005	2.786	- - -
3.08	.298	.0287	-.0475	.008	2.516	.210	3.09	.305	.0350	-.0654	.008	2.457	.235
3.08	.301	.0045	-.0307	.031	2.133	.493	3.09	.307	.0257	-.0573	.017	2.253	.378
3.08	.303	.0021	-.0296	.036	2.061	.508	3.09	.306	.0178	-.0586	.027	2.078	.437
3.08	.304	-.0080	-.0251	.046	1.910	.565	3.09	.313	.0097	-.0495	.035	1.889	.479
a4.11	.410	.0379	-.0593	- - -	- - -	- - -	a4.10	.389	.0525	-.0546	- - -	- - -	- - -
4.12	.415	.0396	-.0731	-.004	2.747	- - -	4.11	.390	.0580	-.0914	-.005	2.736	- - -
4.12	.421	.0308	-.0663	.009	2.503	.228	4.11	.398	.0468	-.0819	.009	2.458	.239
4.12	.426	.0189	-.0606	.025	2.260	.405	4.11	.406	.0339	-.0760	.018	2.278	.373
4.12	.431	.0096	-.0571	.036	2.064	.509	4.11	.418	.0243	-.0735	.027	2.069	.455
4.12	.434	-.0008	-.0541	.046	1.983	.569	4.12	.417	.0184	-.0727	.036	1.893	.489
a5.14	.508	.0494	-.0740	- - -	- - -	- - -	a5.12	.455	.0668	-.0666	- - -	- - -	- - -
5.15	.516	.0586	-.0690	-.004	2.750	- - -	5.13	.476	.0677	-.0931	-.004	2.747	- - -
5.15	.518	.0486	-.0819	.009	2.518	.223	5.13	.483	.0557	-.0856	.011	2.419	.261
5.15	.523	.0303	-.0775	.024	2.279	.416	5.14	.490	.0460	-.0848	.019	2.283	.393
5.15	.529	.0200	-.0747	.037	2.059	.521	5.14	.500	.0386	-.0826	.029	2.088	.460
5.15	.533	.0135	-.0748	.046	1.989	.563	5.14	.505	.0316	-.0833	.036	1.886	.493
a6.16	.574	.0641	-.0825	- - -	- - -	- - -	a6.14	.538	.0790	-.0798	- - -	- - -	- - -
6.17	.596	.0667	-.0984	-.004	2.760	- - -	6.15	.547	.0829	-.0932	-.004	2.750	- - -
6.17	.601	.0566	-.0908	.009	2.518	.229	6.15	.561	.0702	-.0931	.011	2.461	.273
6.17	.607	.0477	-.0877	.024	2.266	.417	6.16	.568	.0635	-.0940	.020	2.238	.385
6.17	.614	.0365	-.0856	.036	2.076	.519	6.16	.585	.0518	-.0949	.030	2.084	.471
6.17	.620	.0267	-.0847	.046	1.937	.570	6.16	.581	.0467	-.0955	.036	1.891	.503
a7.17	.642	.0817	-.0934	- - -	- - -	- - -	a7.16	.608	.0977	-.0934	- - -	- - -	- - -
7.18	.670	.0943	-.0987	-.004	2.728	- - -	7.17	.630	.1011	-.1064	-.004	2.768	- - -
7.18	.669	.0784	-.0940	.010	2.519	.233	7.17	.636	.0883	-.1085	.011	2.439	.271
7.19	.682	.0686	-.0919	.024	2.264	.404	7.18	.647	.0798	-.1055	.021	2.289	.387
7.19	.689	.0537	-.0909	.037	2.078	.528	7.18	.658	.0731	-.1072	.030	2.038	.468
7.19	.696	.0466	-.0910	.047	1.940	.576	7.18	.664	.0694	-.1088	.035	1.986	.496
a8.19	.705	.0997	-.1181	- - -	- - -	- - -	a8.18	.687	.1169	-.1246	- - -	- - -	- - -
8.20	.751	.1030	-.1019	-.004	2.768	- - -	8.19	.696	.1204	-.1185	-.004	2.773	- - -
8.10	.746	.0947	-.1087	.009	2.586	.236	8.19	.716	.1064	-.1213	.011	2.440	.279
8.10	.756	.0869	-.1015	.023	2.274	.464	8.19	.724	.1008	-.1195	.020	2.243	.401
8.11	.764	.0745	-.1081	.037	2.068	.531	8.20	.738	.0978	-.1251	.029	2.055	.467
8.11	.772	.0686	-.1087	.048	1.957	.571	8.20	.741	.0884	-.1261	.035	1.939	.485
a9.20	.768	.1218	-.1421	- - -	- - -	- - -	a9.19	.746	.1413	-.1436	- - -	- - -	- - -
9.21	.793	.1253	-.1218	-.005	2.791	- - -	9.20	.765	.1403	-.1454	-.005	2.764	- - -
9.22	.814	.1178	-.1170	.009	2.530	.244	9.21	.787	.1340	-.1465	.010	2.469	.260
9.22	.827	.1044	-.1164	.024	2.270	.436	9.21	.799	.1256	-.1490	.020	2.259	.406
9.23	.835	.1008	-.1139	.037	2.082	.530	9.22	.808	.1161	-.1371	.029	2.065	.489
9.23	.842	.0987	-.1135	.049	1.968	.570	9.22	.811	.1110	-.1483	.035	1.960	.514
a10.21	.809	.1476	-.1748	- - -	- - -	- - -	a10.21	.808	.1675	-.1983	- - -	- - -	- - -
10.22	.851	.1495	-.1369	-.005	2.816	- - -	10.22	.837	.1688	-.1748	-.005	2.807	- - -
10.23	.880	.1403	-.1285	.011	2.546	.258	10.23	.868	.1604	-.1707	.011	2.469	.278
10.24	.892	.1334	-.1250	.025	2.276	.437	10.23	.876	.1541	-.1669	.021	2.253	.415
10.24	.901	.1230	-.1233	.036	2.082	.537	10.23	.879	.1440	-.1658	.029	2.098	.475
10.24	.903	.1189	-.1217	.046	1.978	.566	10.24	.885	.1398	-.1657	.034	1.960	.517

aProps off.

NACA

TABLE IV.- LONGITUDINAL CHARACTERISTICS OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10; TAIL HEIGHT = 0 b/2, i_t = -4°, β = 51°, R = 1,000,000

(a) M = 0.70, 0.80, 0.83

M, 0.70						
α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
[a]2.03	0.140	0.0216	0.0446	---	---	---
2.03	.131	.0248	.0233	-0.003	2.770	---
2.03	.127	.0137	.0321	.009	2.530	0.243
2.03	.124	.0007	.0455	.025	2.294	.438
2.03	.121	-.0133	.0597	.044	2.086	.528
2.03	.120	-.0251	.0676	.059	1.925	.664
[a]3.06	.243	.0290	.0095	---	---	---
3.06	.233	.0252	.0071	-.002	2.775	---
3.06	.233	.0141	.0168	.010	2.524	.244
3.06	.237	-.0001	.0256	.029	2.276	.459
3.06	.236	-.0129	.0363	.044	2.089	.595
3.06	.236	-.0247	.0402	.059	1.931	.669
[a]4.09	.341	.0257	.0009	---	---	---
4.09	.335	.0270	-.0067	-.002	2.771	---
4.09	.335	.0168	.0011	.009	2.540	.221
4.09	.339	.0066	.0089	.027	2.295	.442
4.09	.348	-.0102	.0141	.044	2.049	.595
4.09	.349	-.0225	.0183	.059	1.927	.666
[a]5.12	.440	.0464	-.0169	---	---	---
5.12	.435	.0391	-.0159	-.002	2.767	---
5.12	.437	.0195	-.0151	.010	2.534	.218
5.12	.444	.0050	-.0079	.028	2.285	.438
5.12	.450	-.0069	-.0013	.045	2.091	.582
5.12	.455	-.0187	.0024	.059	1.928	.665
[a]6.14	.558	.0503	-.0389	---	---	---
6.14	.533	.0533	-.0380	-.001	2.773	---
6.14	.531	.0285	-.0300	.011	2.537	.238
6.14	.544	.0096	-.0219	.029	2.290	.456
6.15	.552	-.0024	-.0158	.045	2.093	.592
6.15	.557	-.0127	-.0123	.059	1.933	.664
[a]7.17	.629	.0570	-.0749	---	---	---
7.17	.627	.0595	-.0469	-.001	2.779	---
7.17	.630	.0459	-.0594	.012	2.586	.242
7.17	.642	.0158	-.0558	.030	2.279	.468
7.18	.650	.0048	-.0294	.047	2.069	.600
7.18	.657	-.0045	-.0265	.059	1.938	.670
[a]8.19	.714	.0488	-.0879	---	---	---
8.19	.717	.0495	-.0748	-.001	2.783	---
8.20	.726	.0406	-.0712	.011	2.571	.236
8.20	.734	.0282	-.0436	.028	2.299	.458
8.20	.745	.0172	-.0582	.046	2.101	.598
8.20	.753	.0074	-.0561	.060	1.945	.677
[a]9.20	.777	.0686	-.0898	---	---	---
9.21	.791	.0661	-.0609	0	2.792	---
9.21	.803	.0566	-.0566	.012	2.547	.255
9.22	.816	.0430	-.0519	.030	2.288	.475
9.22	.826	.0338	-.0487	.046	2.098	.604
9.22	.831	.0272	-.0447	.061	1.945	.676
[a]10.21	.833	.0925	-.0939	---	---	---
10.22	.837	.0821	-.0679	-.001	2.806	---
10.23	.866	.0787	-.0482	.013	2.734	.262
10.23	.880	.0677	-.0715	.029	2.294	.472
10.24	.890	.0567	-.0498	.047	2.059	.614
10.24	.900	.0494	-.0405	.059	1.956	.679

M, 0.80						
α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
[a]2.04	0.149	0.0246	0.0486	---	---	---
2.03	.140	.0262	.0190	-0.004	2.775	---
2.03	.138	.0188	.0286	.007	2.548	0.203
2.03	.136	.0046	.0437	.024	2.276	.482
2.03	.135	-.0064	.0534	.039	2.088	.541
2.03	.135	-.0184	.0573	.046	1.996	.584
[a]3.07	.261	.0249	.0170	---	---	---
3.06	.251	.0207	.0051	-.004	2.775	---
3.06	.251	.0185	.0132	.008	2.537	.211
3.06	.252	.0064	.0247	.024	2.291	.412
3.06	.274	-.0077	.0314	.038	2.096	.539
3.07	.255	-.0111	.0349	.046	2.008	.587
[a]4.10	.370	.0270	-.0008	---	---	---
4.10	.362	.0307	-.0086	-.004	2.760	---
4.10	.365	.0211	-.0002	.008	2.538	.209
4.10	.370	.0081	.0070	.024	2.407	.409
4.10	.373	-.0017	.0133	.038	2.109	.533
4.10	.378	-.0079	.0159	.046	2.008	.584
[a]5.13	.478	.0324	-.0185	---	---	---
5.13	.474	.0322	-.0243	-.003	2.763	---
5.13	.481	.0271	-.0419	.008	2.552	.201
5.14	.485	.0134	-.0102	.025	2.291	.419
5.14	.490	.0057	-.0060	.038	2.124	.530
5.14	.494	-.0027	-.0037	.046	2.020	.587
[a]6.16	.577	.0433	-.0399	---	---	---
6.16	.580	.0439	-.0372	-.003	2.771	---
6.16	.583	.0352	-.0313	.010	2.554	.222
6.16	.592	.0266	-.0276	.026	2.298	.480
6.17	.598	.0147	-.0211	.039	2.125	.551
6.17	.600	.0095	-.0192	.047	2.030	.581
[a]7.18	.651	.0576	-.0485	---	---	---
7.18	.671	.0592	-.0432	-.004	2.774	---
7.19	.680	.0498	-.0406	.008	2.555	.208
7.19	.685	.0397	-.0345	.024	2.317	.405
7.19	.687	.0320	-.0320	.036	2.175	.517
7.19	.690	.0279	-.0295	.045	2.045	.570
[a]8.19	.705	.0772	-.0477	---	---	---
8.20	.733	.0769	-.0366	-.005	2.788	---
8.20	.744	.0699	-.0338	.008	2.560	.206
8.20	.752	.0561	-.0305	.022	2.338	.415
8.21	.756	.0517	-.0281	.036	2.163	.580
8.21	.761	.0463	-.0260	.045	2.048	.582
[a]9.19	.772	.0909	-.0846	---	---	---
9.20	.784	.0905	-.0539	-.005	2.794	---
9.21	.805	.0904	-.0460	.007	2.571	.211
9.22	.822	.0780	-.0375	.023	2.319	.417
9.22	.822	.0726	-.0383	.035	2.167	.528
9.22	.825	.0680	-.0392	.045	2.048	.582
[a]10.20	.800	.1250	-.0915	---	---	---
10.21	.852	.1277	-.0447	-.006	2.800	---
10.22	.862	.1143	-.0449	.007	2.571	.222
10.23	.867	.1061	-.0431	.021	2.337	.409
10.23	.874	.0895	-.0394	.033	2.182	.516
10.23	.880	.0877	-.0418	.044	2.056	.587

M, 0.83						
α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
[a]2.04	0.154	0.0269	0.0470	---	---	---
2.04	.146	.0297	.0193	-0.004	2.738	---
2.04	.142	.0212	.0288	.008	2.559	0.188
2.04	.141	.0117	.0391	.019	2.349	.346
2.04	.140	-.0006	.0527	.035	2.124	.496
2.04	.138	-.0117	.0610	.048	1.948	.575
[a]3.07	.263	.0278	.0030	---	---	---
3.07	.262	.0302	.0058	-.003	2.732	---
3.07	.261	.0223	.0023	.006	2.566	.171
3.07	.262	.0186	.0215	.018	2.361	.345
3.07	.265	-.0004	.0399	.035	2.101	.505
3.07	.269	-.0095	.0306	.047	1.970	.574
[a]4.10	.364	.0308	.0089	---	---	---
4.10	.361	.0340	-.0097	-.003	2.745	---
4.11	.365	.0278	-.0041	.006	2.578	.149
4.10	.364	.0160	.0075	.018	2.361	.344
4.11	.388	.0080	.0132	.036	2.112	.522
4.11	.398	-.0063	.0160	.046	1.971	.579
[a]5.14	.490	.0402	-.0141	---	---	---
5.14	.494	.0416	-.0249	-.003	2.743	---
5.14	.497	.0337	-.0195	.004	2.565	.177
5.14	.500	.0240	-.0151	.016	2.377	.351
5.14	.507	.0109	-.0098	.032	2.119	.525
5.14	.513	.0059	-.0064	.043	1.977	.589
[a]6.16	.570	.0731	-.0481	---	---	---
6.16	.588	.0731	-.0368	-.003	2.751	---
6.17	.597	.0476	-.0316	.006	2.583	.167
6.17	.590	.0372	-.0262	.019	2.365	.358
6.17	.604	.0250	-.0216	.036	2.130	.524
6.17	.610	.0179	-.0197	.047	1.991	.580
[a]7.17	.657	.0695	-.0273	---	---	---
7.18	.667	.0702	-.0392	-.003	2.764	---
7.18	.672	.0632	-.0332	.007	2.578	.176
7.18	.673	.0540	-.0269	.018	2.359	.328
7.19	.676	.0482	-.0230	.035	2.147	.530
7.19	.685	.0345	-.0219	.045	2.007	.584
[a]8.19	.697	.0873	-.0543	---	---	---
8.20	.726	.0825	-.0302	-.004	2.776	---
8.20	.738	.0804	-.0333	.007	2.574	.194
8.20	.746	.0731	-.0296	.018	2.364	.357
8.20	.739	.0610	-.0260	.033	2.131	.523
8.21	.783	.0566	-.0256	.045	2.018	.576
[a]9.19	.747	.1088	-.0488	---	---	---
9.20	.781	.1067	-.0368	-.004	2.798	---
9.21	.802	.1019	-.0320	.006	2.592	.195
9.22	.816	.0927	-.0329	.018	2.377	.372
9.22	.825	.0846	-.0285	.033	2.177	.520
9.22	.834	.0765	-.0299	.044	2.016	.584
[a]10.19	.781	.1314	-.0840	---	---	---
10.21	.829	.1337	-.0432	-.005	2.802	---
10.22	.847	.1328	-.0410	.005	2.599	.198
10.23	.870	.1209	-.0349	.017	2.381	.373
10.24	.887	.1097	-.0304	.034	2.161	.528
10.23	.897	.1080	-.0363	.044	2.039	.587

[a]Props off.

NACA

TABLE IV.- LONGITUDINAL CHARACTERISTICS OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10; TAIL HEIGHT = 0 b/2, i_t = -4°, β = 51°, R = 1,000,000 - Concluded

(b) M = 0.86, 0.90

M, 0.86						
α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
^{a}2.04	0.166	0.0297	0.0501	- - -	- - -	- - -
2.04	.158	.0331	.0800	-0.005	2.727	- - -
2.04	.152	.0284	.0387	.007	2.510	0.209
2.04	.151	.0133	.0484	.018	2.316	.354
2.04	.148	-.0006	.0561	.033	2.070	.506
2.04	.150	-.0094	.0656	.046	1.881	.547
^{a}3.08	.283	.0513	.0027	- - -	- - -	- - -
3.08	.282	.0554	-.0018	-.005	2.734	- - -
3.08	.280	.0855	.0097	.006	2.562	.197
3.08	.279	.0157	.0193	.017	2.337	.317
3.08	.281	.0089	.0316	.033	2.084	.450
3.08	.281	-.0076	.0414	.045	1.912	.561
^{a}4.11	.398	.0379	.0027	- - -	- - -	- - -
4.09	.398	.0415	-.0211	-.005	2.741	- - -
4.11	.403	.0339	-.0133	.006	2.551	.174
4.11	.405	.0251	-.0041	.016	2.367	.389
4.11	.410	.0098	.0061	.034	2.084	.509
4.12	.415	-.0001	.0078	.045	1.914	.556
^{a}5.13	.483	.0500	-.0197	- - -	- - -	- - -
5.14	.498	.0521	-.0318	-.004	2.742	- - -
5.14	.499	.0439	-.0238	.007	2.541	.198
5.14	.503	.0358	-.0184	.018	2.339	.354
5.14	.508	.0243	-.0139	.032	2.104	.496
5.14	.515	.0110	-.0105	.045	1.980	.575
^{a}6.15	.554	.0640	-.0809	- - -	- - -	- - -
6.16	.577	.0673	-.0378	-.004	2.745	- - -
6.16	.581	.0578	-.0896	.006	2.578	.193
6.16	.584	.0481	-.0851	.018	2.341	.363
6.16	.589	.0405	-.0884	.032	2.129	.498
6.17	.597	.0283	-.0198	.045	1.952	.569
^{a}7.16	.628	.0809	-.0359	- - -	- - -	- - -
7.18	.649	.0689	-.0351	-.004	2.773	- - -
7.18	.650	.0753	-.0308	.007	2.544	.204
7.18	.654	.0654	-.0285	.018	2.354	.361
7.18	.664	.0555	-.0244	.032	2.129	.505
7.18	.671	.0479	-.0285	.044	1.944	.569
^{a}8.18	.688	.0981	-.0381	- - -	- - -	- - -
8.19	.706	.1002	-.0374	-.004	2.766	- - -
8.19	.724	.0947	-.0368	.007	2.556	.202
8.20	.729	.0874	-.0385	.018	2.359	.361
8.20	.740	.0758	-.0398	.034	2.105	.511
8.20	.748	.0680	-.0389	.045	1.949	.571
^{a}9.19	.739	.1196	-.0549	- - -	- - -	- - -
9.20	.769	.1218	-.0449	-.005	2.783	- - -
9.21	.791	.1177	-.0435	.006	2.590	.187
9.21	.800	.1084	-.0405	.019	2.363	.374
9.21	.808	.0981	-.0389	.033	2.134	.504
9.22	.815	.0914	-.0368	.044	1.968	.578
^{a}10.19	.780	.1404	-.0765	- - -	- - -	- - -
10.21	.823	.1432	-.0535	.005	2.799	- - -
10.22	.844	.1402	-.0471	.007	2.575	.213
10.22	.860	.1347	-.0430	.019	2.328	.370
10.23	.872	.1258	-.0486	.033	2.146	.506
10.23	.880	.1175	-.0584	.044	1.980	.578

M, 0.90						
α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
^{a}2.04	0.168	0.0390	0.0484	- - -	- - -	- - -
2.04	.170	.0445	-.0018	-0.004	2.705	- - -
2.04	.166	.0333	.0184	.006	2.479	0.194
2.04	.164	.0216	.0303	.017	2.289	.350
2.04	.168	.0138	.0415	.027	2.038	.408
2.04	.160	.0066	.0510	.036	1.854	.470
^{a}3.07	.262	.0429	.0259	- - -	- - -	- - -
3.08	.277	.0461	-.0048	-.003	2.708	- - -
3.08	.277	.0369	-.0060	.005	2.490	.193
3.08	.280	.0241	.0059	.018	2.297	.365
3.08	.280	.0175	.0065	.027	2.040	.432
3.08	.286	.0127	.0066	.035	1.879	.464
^{a}4.09	.378	.0597	.0038	- - -	- - -	- - -
4.10	.384	.0574	-.0261	-.004	2.729	- - -
4.10	.374	.0461	-.0208	.006	2.504	.270
4.10	.374	.0378	-.0166	.017	2.254	.349
4.11	.387	.0268	-.0110	.020	2.033	.443
4.11	.387	.0213	-.0103	.035	1.890	.464
^{a}5.11	.431	.0679	-.0108	- - -	- - -	- - -
5.12	.455	.0680	-.0528	-.004	2.733	- - -
5.12	.450	.0599	-.0461	.006	2.513	.193
5.13	.466	.0468	-.0444	.018	2.243	.371
5.13	.467	.0404	-.0391	.027	2.054	.440
5.13	.469	.0379	-.0287	.035	1.900	.463
^{a}6.13	.506	.0796	-.0183	- - -	- - -	- - -
6.14	.534	.0806	-.0354	-.004	2.747	- - -
6.14	.533	.0722	-.0352	.006	2.582	.186
6.15	.546	.0615	-.0336	.019	2.352	.353
6.15	.554	.0567	-.0355	.027	2.076	.446
6.15	.562	.0491	-.0345	.035	1.983	.485
^{a}7.15	.583	.0945	-.0301	- - -	- - -	- - -
7.16	.605	.1009	-.0456	-.005	2.757	- - -
7.16	.613	.0912	-.0459	.006	2.542	.181
7.17	.627	.0810	-.0440	.019	2.868	.355
7.17	.635	.0763	-.0454	.028	2.066	.457
7.17	.638	.0719	-.0440	.034	1.954	.480
^{a}8.17	.654	.1156	-.0581	- - -	- - -	- - -
8.18	.677	.1200	-.0543	-.005	2.707	- - -
8.18	.693	.1186	-.0599	.006	2.547	.192
8.18	.699	.1054	-.0576	.018	2.884	.361
8.19	.710	.0988	-.0514	.028	2.061	.478
8.19	.714	.0939	-.0611	.033	1.964	.488
^{a}9.18	.719	.1360	-.0758	- - -	- - -	- - -
9.19	.739	.1435	-.0643	-.006	2.789	- - -
9.20	.761	.1388	-.0665	.006	2.548	.197
9.20	.773	.1353	-.0635	.019	2.285	.354
9.20	.779	.1168	-.0683	.028	2.095	.488
9.20	.788	.1151	-.0646	.034	1.981	.506
^{a}10.19	.784	.1618	-.1021	- - -	- - -	- - -
10.21	.811	.1675	-.0848	-.006	2.754	- - -
10.22	.840	.1679	-.0905	.007	2.571	.189
10.22	.848	.1543	-.0845	.018	2.306	.389
10.22	.855	.1483	-.0813	.027	2.111	.478
10.22	.857	.1405	-.0784	.033	1.999	.517

^{a}Props off.

NACA

TABLE V.- LONGITUDINAL CHARACTERISTICS OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10; TAIL HEIGHT = 0 b/2, $i_t = -6^{\circ}$, $\beta = 51^{\circ}$, R = 1,000,000

(a) M = 0.70, 0.80, 0.83

M, 0.70							M, 0.80							M, 0.83						
α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$	α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$	α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
2.03	0.118	0.0285	0.1103	---	---	---	2.03	0.126	0.0258	0.1134	---	---	---	2.03	0.133	0.0278	0.1168	---	---	---
2.02	.109	.0258	.0860	-0.003	2.772	---	2.03	.119	.0291	.0879	-0.004	2.745	---	2.03	.123	.0310	.0885	-0.004	2.753	---
2.02	.107	.0160	.0948	.007	2.578	0.203	2.03	.115	.0185	.0995	.006	2.511	0.283	2.03	.121	.0241	.0951	.005	2.594	0.154
2.02	.103	.0027	.1047	.024	2.321	.413	2.02	.113	.0075	.1096	.021	2.306	.396	2.03	.118	.0124	.1082	.018	2.354	.326
2.02	.100	-.0093	.1205	.040	2.125	.562	2.02	.111	-.0038	.1234	.036	2.111	.521	2.03	.117	.0015	.1211	.033	2.154	.488
2.02	.098	-.0214	.1309	.056	1.958	.651	2.02	.110	-.0142	.1323	.050	1.949	.598	2.03	.115	-.0102	.1317	.046	1.972	.585
3.07	.221	.0285	.0651	---	---	---	3.06	.236	.0254	.0654	---	---	---	3.06	.247	.0276	.0699	---	---	---
3.05	.213	.0252	.0689	-.002	2.777	---	3.06	.235	.0290	.0703	-.004	2.750	---	3.06	.242	.0308	.0668	-.003	2.770	---
3.05	.211	.0157	.0758	.008	2.556	.210	3.06	.230	.0219	.0769	.004	2.589	.196	3.06	.240	.0233	.0756	.006	2.580	.164
3.05	.209	.0024	.0908	.025	2.328	.385	3.06	.230	.0084	.0948	.021	2.319	.396	3.06	.240	.0148	.0872	.016	2.387	.337
3.05	.209	-.0095	.1034	.041	2.130	.566	3.06	.230	-.0029	.1051	.036	2.121	.514	3.06	.241	.0032	.1007	.031	2.183	.478
3.05	.209	-.0213	.1114	.056	1.966	.652	3.06	.230	-.0133	.1121	.049	1.965	.558	3.06	.241	-.0094	.1128	.046	1.978	.561
4.08	.321	.0239	.0645	---	---	---	4.09	.347	.0271	.0675	---	---	---	4.10	.364	.0307	.0700	---	---	---
4.08	.314	.0267	.0535	-.002	2.774	---	4.09	.344	.0311	.0550	-.004	2.745	---	4.10	.361	.0340	.0526	-.003	2.748	---
4.08	.312	.0176	.0602	.008	2.564	.198	4.09	.341	.0225	.0623	.006	2.563	.182	4.10	.359	.0269	.0590	.005	2.589	.154
4.08	.314	.0074	.0692	.021	2.379	.373	4.09	.345	.0109	.0755	.021	2.330	.380	4.10	.360	.0172	.0709	.017	2.392	.333
4.08	.315	-.0072	.0794	.038	2.176	.533	4.09	.349	-.0005	.0837	.036	2.196	.515	4.10	.362	.0068	.0817	.031	2.188	.480
4.08	.318	-.0196	.0864	.055	1.973	.651	4.09	.350	-.0118	.0887	.049	1.969	.605	4.10	.365	-.0065	.0882	.045	1.986	.586
5.11	.419	.0260	.0445	---	---	---	5.12	.457	.0319	.0474	---	---	---	5.13	.469	.0362	.0478	---	---	---
5.11	.419	.0289	.0383	-.002	2.768	---	5.12	.459	.0353	.0309	-.004	2.748	---	5.13	.474	.0407	.0331	-.003	2.772	---
5.11	.419	.0218	.0437	.006	2.585	.162	5.12	.457	.0267	.0474	.006	2.574	.175	5.13	.475	.0349	.0409	.005	2.606	.149
5.11	.418	.0094	.0527	.021	2.375	.385	5.12	.463	.0196	.0566	.021	2.338	.393	5.13	.478	.0249	.0493	.017	2.395	.334
5.11	.425	-.0083	.0600	.037	2.183	.555	5.13	.467	.0040	.0617	.036	2.132	.582	5.13	.482	.0132	.0555	.031	2.298	.486
5.11	.428	-.0162	.0649	.055	1.979	.651	5.13	.470	-.0062	.0660	.048	1.986	.608	5.14	.487	.0096	.0607	.045	2.003	.587
6.14	.519	.0301	.0216	---	---	---	6.15	.557	.0425	.0216	---	---	---	6.15	.558	.0510	.0300	---	---	---
6.13	.513	.0322	.0209	-.001	2.769	---	6.16	.565	.0447	.0203	-.004	2.755	---	6.16	.569	.0534	.0194	-.003	2.760	---
6.14	.517	.0244	.0258	.008	2.572	.187	6.16	.562	.0356	.0282	.007	2.576	.175	6.16	.575	.0487	.0270	.006	2.607	.153
6.14	.520	.0149	.0336	.021	2.388	.373	6.16	.568	.0252	.0358	.020	2.363	.360	6.16	.572	.0369	.0369	.018	2.391	.340
6.14	.527	.0021	.0412	.037	2.182	.541	6.16	.572	.0158	.0395	.033	2.180	.457	6.16	.580	.0280	.0424	.031	2.202	.481
6.14	.532	-.0106	.0476	.054	1.988	.651	6.16	.577	.0046	.0450	.049	1.991	.606	6.16	.586	.0164	.0471	.045	2.015	.585
7.16	.609	.0361	.0008	---	---	---	7.17	.633	.0566	.0116	---	---	---	7.16	.682	.0681	.0272	---	---	---
7.16	.607	.0381	.0082	-.001	2.781	---	7.18	.654	.0573	.0098	-.004	2.768	---	7.18	.651	.0687	.0188	-.004	2.771	---
7.16	.612	.0301	.0142	.009	2.572	.198	7.18	.661	.0497	.0187	.007	2.582	.183	7.18	.654	.0615	.0241	.006	2.597	.167
7.16	.619	.0206	.0199	.022	2.385	.376	7.18	.662	.0480	.0250	.019	2.379	.354	7.18	.654	.0547	.0343	.017	2.399	.341
7.17	.627	.0058	.0250	.039	2.177	.542	7.18	.663	.0305	.0281	.033	2.186	.499	7.18	.657	.0442	.0395	.031	2.194	.464
7.17	.635	-.0025	.0339	.055	1.990	.654	7.18	.669	.0203	.0327	.048	2.000	.604	7.18	.662	.0348	.0486	.044	2.033	.579
8.19	.695	.0476	-.0032	---	---	---	8.18	.686	.0749	.0135	---	---	---	8.18	.676	.0894	.0207	---	---	---
8.19	.699	.0475	-.0017	-.001	2.789	---	8.19	.716	.0769	.0202	-.005	2.776	---	8.19	.708	.0868	.0231	-.004	2.790	---
8.19	.707	.0352	.0068	.010	2.569	.218	8.19	.724	.0690	.0244	.007	2.578	.180	8.19	.722	.0798	.0259	.006	2.603	.177
8.19	.711	.0301	.0120	.023	2.385	.381	8.20	.731	.0577	.0303	.019	2.575	.388	8.20	.727	.0721	.0313	.017	2.400	.345
8.19	.722	.0195	.0188	.038	2.182	.544	8.20	.734	.0492	.0330	.033	2.186	.505	8.20	.731	.0621	.0363	.031	2.195	.495
8.20	.731	.0096	.0244	.056	1.999	.651	8.20	.741	.0412	.0376	.047	2.016	.585	8.20	.741	.0550	.0400	.044	2.035	.579
9.19	.754	.0664	-.0218	---	---	---	9.19	.738	.0966	-.0012	---	---	---	9.19	.731	.1081	.0070	---	---	---
9.20	.775	.0640	-.0026	0	2.793	---	9.20	.766	.0960	.0021	-.005	2.785	---	9.20	.763	.1079	.0186	-.004	2.799	---
9.21	.785	.0574	.0080	.010	2.578	.217	9.20	.784	.0885	.0023	.006	2.577	.199	9.20	.784	.1010	.0233	.005	2.616	.183
9.21	.793	.0487	.0076	.023	2.391	.386	9.21	.797	.0781	.0059	.018	2.374	.378	9.21	.801	.0926	.0297	.016	2.405	.360
9.21	.804	.0371	.0109	.038	2.188	.541	9.21	.799	.0700	.0067	.033	2.179	.514	9.22	.805	.0850	.0389	.029	2.209	.496
9.22	.813	.0270	.0147	.055	2.010	.648	9.22	.805	.0629	.0061	.045	2.029	.600	9.22	.815	.0776	.0357	.040	2.048	.579
10.21	.810	.0903	-.0234	---	---	---	10.19	.778	.1193	-.0207	---	---	---	10.19	.761	.1286	-.0209	---	---	---
10.22	.840	.0871	-.0003	-.001	2.814	---	10.21	.809	.1156	.0178	-.006	2.798	---	10.21	.808	.1287	.0184	-.005	2.806	---
10.22	.844	.0784	-.0009	.011	2.577	.236	10.21	.825	.1121	.0137	.006	2.559	.169	10.21	.827	.1246	.0247	.004	2.613	.192
10.22	.856	.0688	.0060	.023	2.381	.402	10.22	.842	.1048	.0180	.018	2.386	.379	10.22	.833	.1175	.0204	.014	2.426	.356
10.23	.866	.0586	.0105	.039	2.179	.530	10.22	.855	.0957	.0230	.032	2.199	.510	10.22	.843	.1080	.0177	.027	2.217	.499
10.23	.877	.0499	.0153	.055	2.025	.646	10.22	.862	.0874	.0280	.045	2.050	.607	10.22	.852	.0999	.0106	.041	2.055	.587

NACA

TABLE V.- LONGITUDINAL CHARACTERISTICS OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10; TAIL HEIGHT = 0 b/2, i_t = -6°, β = 51°, R = 1,000,000 - Concluded

(b) M = 0.86, 0.90

M, 0.86							M, 0.90						
α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$	α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
2.03	0.148	0.0899	0.1803	- - -	- - -	- - -	2.03	0.140	0.0411	0.1243	- - -	- - -	- - -
2.03	.139	.0374	.0900	-0.003	2.731	- - -	2.03	.144	.0480	.0710	-0.005	2.711	- - -
2.03	.130	.0260	.1009	.006	2.547	0.182	2.03	.145	.0369	.0877	.005	2.486	0.184
2.03	.129	.0187	.1145	.021	2.281	.300	2.03	.143	.0230	.1098	.018	2.285	.347
2.03	.128	.0031	.1277	.034	2.095	.486	2.03	.141	.0187	.1264	.027	2.085	.430
2.03	.126	-.0100	.1431	.047	1.874	.554	2.03	.138	.0063	.1364	.035	1.861	.465
3.07	.261	.0314	.0988	- - -	- - -	- - -	3.06	.259	.0474	.1050	- - -	- - -	- - -
3.07	.261	.0376	.0637	-.003	2.740	- - -	3.07	.257	.0463	.0900	-.005	2.727	- - -
3.07	.259	.0270	.0723	.005	2.529	.179	3.07	.258	.0375	.0687	.007	2.461	.199
3.07	.260	.0256	.0900	.020	2.307	.373	3.07	.261	.0309	.0795	.018	2.244	.345
3.07	.260	.0037	.1047	.034	2.081	.489	3.07	.263	.0201	.0887	.027	2.044	.425
3.07	.260	-.0080	.1176	.047	1.891	.587	3.07	.268	.0180	.0955	.036	1.879	.464
4.10	.371	.0370	.0708	- - -	- - -	- - -	4.08	.347	.0397	.0797	- - -	- - -	- - -
4.10	.378	.0418	.0438	-.003	2.744	- - -	4.09	.347	.0387	.0338	-.005	2.787	- - -
4.10	.380	.0334	.0528	.005	2.528	.178	4.09	.347	.0479	.0582	.007	2.470	.204
4.10	.383	.0251	.0687	.020	2.304	.380	4.09	.356	.0366	.0648	.019	2.235	.356
4.11	.386	.0089	.0783	.033	2.093	.518	4.10	.359	.0288	.0678	.027	2.045	.429
4.11	.391	-.0004	.0838	.047	1.901	.573	4.10	.360	.0248	.0719	.035	1.868	.465
5.12	.461	.0498	.0483	- - -	- - -	- - -	5.11	.430	.0627	.0609	- - -	- - -	- - -
5.13	.460	.0528	.0096	-.003	2.749	- - -	5.11	.431	.0676	.0383	-.004	2.734	- - -
5.13	.479	.0449	.0400	.006	2.566	.179	5.12	.437	.0569	.0451	.008	2.479	.227
5.13	.483	.0380	.0513	.020	2.317	.381	5.12	.441	.0457	.0501	.019	2.244	.362
5.14	.488	.0229	.0558	.032	2.181	.498	5.12	.448	.0437	.0539	.028	2.050	.430
5.14	.493	.0103	.0598	.046	1.913	.583	5.12	.449	.0353	.0556	.035	1.899	.460
6.14	.533	.0644	.0408	- - -	- - -	- - -	6.13	.489	.0795	.0478	- - -	- - -	- - -
6.15	.556	.0671	.0227	-.004	2.751	- - -	6.13	.508	.0798	.0285	-.004	2.745	- - -
6.15	.560	.0576	.0319	.005	2.578	.180	6.13	.516	.0722	.0351	.009	2.469	.239
6.15	.564	.0471	.0387	.020	2.384	.388	6.14	.525	.0629	.0376	.019	2.248	.390
6.16	.572	.0363	.0435	.034	2.104	.514	6.14	.538	.0548	.0349	.029	2.035	.469
6.16	.579	.0260	.0461	.047	1.919	.580	6.14	.543	.0501	.0354	.035	1.918	.494
7.16	.604	.0795	.0315	- - -	- - -	- - -	7.14	.566	.0918	.0309	- - -	- - -	- - -
7.14	.630	.0886	.0180	-.004	2.763	- - -	7.15	.588	.0968	.0147	-.004	2.748	- - -
7.17	.636	.0741	.0298	.006	2.500	.185	7.15	.595	.0881	.0231	.008	2.489	.240
7.17	.638	.0689	.0360	.020	2.385	.391	7.16	.605	.0785	.0248	.019	2.248	.398
7.18	.645	.0546	.0388	.032	2.131	.523	7.16	.613	.0788	.0254	.028	2.053	.464
7.18	.653	.0438	.0485	.045	1.943	.583	7.16	.617	.0667	.0263	.034	1.932	.496
8.17	.666	.0973	.0173	- - -	- - -	- - -	8.16	.638	.1115	.0071	- - -	- - -	- - -
8.18	.682	.1003	.0188	-.005	2.775	- - -	8.17	.650	.1167	.0060	-.004	2.765	- - -
8.19	.707	.0988	.0238	.006	2.579	.200	8.17	.674	.1087	.0116	.008	2.489	.248
8.19	.714	.0819	.0303	.021	2.383	.395	8.18	.682	.0997	.0161	.019	2.259	.405
8.19	.722	.0730	.0343	.033	2.127	.518	8.18	.686	.0914	.0169	.028	2.080	.469
8.20	.730	.0649	.0362	.045	1.956	.583	8.18	.693	.0882	.0167	.035	1.940	.501
9.18	.744	.1190	.0005	- - -	- - -	- - -	9.18	.699	.1369	-.0136	- - -	- - -	- - -
9.19	.758	.1219	.0128	-.005	2.787	- - -	9.18	.728	.1375	-.0008	-.005	2.779	- - -
9.20	.773	.1139	.0173	.006	2.585	.198	9.19	.740	.1373	.0021	.003	2.612	.167
9.20	.782	.1097	.0226	.021	2.331	.389	9.19	.751	.1217	.0048	.017	2.309	.381
9.21	.791	.0938	.0251	.033	2.131	.515	9.20	.758	.1148	.0074	.026	2.138	.464
9.21	.801	.0878	.0304	.045	1.977	.586	9.20	.765	.1085	.0073	.035	1.954	.517
10.19	.779	.1399	-.0100	- - -	- - -	- - -	10.19	.768	.1613	-.0077	- - -	- - -	- - -
10.21	.807	.1468	.0107	-.006	2.798	- - -	10.20	.791	.1615	-.0094	-.005	2.795	- - -
10.21	.825	.1364	.0191	.006	2.601	.202	10.21	.821	.1603	-.0079	.006	2.564	.203
10.22	.844	.1606	.0187	.021	2.341	.400	10.21	.826	.1538	-.0070	.017	2.321	.385
10.22	.872	.1285	.0233	.033	2.148	.520	10.21	.839	.1448	-.0086	.026	2.186	.471
10.22	.889	.1139	.0266	.045	1.978	.587	10.22	.838	.1396	-.0096	.034	1.991	.514

TABLE VI.- LONGITUDINAL CHARACTERISTICS OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10; TAIL OFF, $\beta = 51^{\circ}$, R = 1,000,000

(a) M = 0.70, 0.80, 0.83

M, 0.70						
α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
a2.04	0.169	0.0201	-0.0466	- - -	- - -	- - -
2.04	.159	.0233	-.0695	-0.003	2.783	- - -
2.04	.154	.0111	-.0587	.011	2.511	0.277
2.04	.152	.0008	-.0498	.023	2.383	.414
2.04	.150	-.0089	-.0422	.037	2.176	.536
2.04	.150	-.0251	-.0336	.056	1.950	.677
a3.07	.262	.0214	-.0431	- - -	- - -	- - -
3.06	.255	.0236	-.0610	-.008	2.700	- - -
3.06	.258	.0136	-.0541	.009	2.541	.283
3.06	.258	.0008	-.0481	.025	2.320	.405
3.06	.258	-.0117	-.0341	.042	2.127	.538
3.06	.258	-.0246	-.0287	.057	1.953	.660
a4.09	.353	.0288	-.0469	- - -	- - -	- - -
4.09	.346	.0254	-.0521	-.008	2.762	- - -
4.09	.346	.0151	-.0452	.011	2.551	.284
4.09	.347	.0029	-.0359	.025	2.330	.425
4.09	.350	-.0089	-.0263	.041	2.144	.542
4.09	.352	-.0203	-.0200	.057	1.958	.657
a5.12	.442	.0258	-.0363	- - -	- - -	- - -
5.12	.437	.0261	-.0438	-.002	2.761	- - -
5.12	.440	.0161	-.0358	.010	2.537	.286
5.12	.444	.0039	-.0261	.026	2.334	.418
5.12	.449	-.0067	-.0173	.042	2.137	.567
5.12	.453	-.0190	-.0110	.057	1.956	.661
a6.14	.535	.0495	-.0337	- - -	- - -	- - -
6.14	.530	.0319	-.0542	-.001	2.761	- - -
6.14	.532	.0216	-.0262	.011	2.587	.237
6.14	.537	.0094	-.0153	.027	2.384	.436
6.14	.543	-.0065	-.0076	.043	2.126	.579
6.15	.549	-.0156	-.0014	.058	1.955	.662
a7.16	.627	.0561	-.0287	- - -	- - -	- - -
7.16	.627	.0575	-.0245	-.001	2.787	- - -
7.16	.620	.0266	-.0133	.012	2.587	.253
7.17	.627	.0171	-.0058	.026	2.335	.495
7.17	.635	.0049	.0029	.043	2.130	.579
7.17	.642	-.0051	.0092	.058	1.964	.661
a8.19	.694	.0473	-.0163	- - -	- - -	- - -
8.19	.701	.0468	-.0097	-.001	2.788	- - -
8.19	.706	.0370	-.0006	.012	2.539	.247
8.19	.711	.0273	.0066	.026	2.342	.442
8.19	.719	.0166	.0147	.042	2.144	.572
8.19	.727	.0068	.0212	.058	1.969	.663
a9.19	.748	.0659	-.0097	- - -	- - -	- - -
9.20	.768	.0630	.0060	0	2.799	- - -
9.20	.776	.0517	.0151	.014	2.556	.266
9.21	.787	.0424	.0208	.027	2.369	.438
9.21	.797	.0318	.0290	.045	2.129	.583
9.22	.805	.0268	.0333	.058	1.980	.663
a10.20	.796	.0898	.0083	- - -	- - -	- - -
10.21	.827	.0857	.0286	-.001	2.809	- - -
10.22	.835	.0746	.0340	.014	2.528	.263
10.22	.844	.0654	.0387	.026	2.337	.438
10.22	.855	.0540	.0468	.045	2.130	.588
10.23	.865	.0458	.0533	.058	1.980	.698

M, 0.80						
α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
a2.05	0.176	0.0231	-0.0478	- - -	- - -	- - -
2.04	.168	.0266	-.0716	-0.004	2.742	- - -
2.04	.166	.0213	-.0671	.001	2.623	0.117
2.04	.164	.0108	-.0585	.014	2.407	.310
2.04	.164	-.0030	-.0471	.031	2.170	.501
2.04	.164	-.0150	-.0407	.049	1.950	.599
a3.08	.279	.0256	-.0473	- - -	- - -	- - -
3.07	.278	.0271	-.0656	-.004	2.740	- - -
3.07	.274	.0195	-.0577	.005	2.572	.170
3.07	.274	.0071	-.0476	.021	2.321	.361
3.08	.276	-.0079	-.0391	.039	2.079	.543
3.08	.277	-.0148	-.0357	.048	1.969	.596
a4.10	.379	.0263	-.0440	- - -	- - -	- - -
4.10	.377	.0297	-.0578	-.004	2.743	- - -
4.10	.377	.0225	-.0496	.005	2.580	.164
4.10	.380	.0099	-.0403	.020	2.334	.378
4.11	.385	-.0055	-.0308	.037	2.107	.555
4.11	.386	.0120	-.0267	.048	1.978	.600
a5.13	.484	.0319	-.0373	- - -	- - -	- - -
5.13	.489	.0345	-.0477	-.003	2.744	- - -
5.13	.494	.0272	-.0408	.006	2.503	.165
5.14	.490	.0150	-.0311	.021	2.336	.378
5.14	.495	.0083	-.0238	.036	2.108	.530
5.14	.496	-.0061	-.0197	.046	1.984	.601
a6.16	.573	.0425	-.0379	- - -	- - -	- - -
6.16	.580	.0439	-.0403	-.003	2.749	- - -
6.16	.583	.0375	-.0324	.006	2.587	.170
6.16	.588	.0246	-.0236	.021	2.338	.361
6.16	.593	.0113	-.0155	.038	2.111	.542
6.17	.596	.0049	-.0029	.048	1.990	.599
a7.18	.646	.0570	-.0273	- - -	- - -	- - -
7.18	.664	.0577	-.0268	-.004	2.755	- - -
7.18	.668	.0498	-.0215	.006	2.589	.174
7.18	.673	.0379	-.0116	.022	2.383	.406
7.18	.676	.0265	-.0068	.036	2.120	.540
7.19	.680	.0198	-.0031	.047	1.992	.600
a8.18	.690	.0751	-.0097	- - -	- - -	- - -
8.19	.720	.0758	-.0088	-.005	2.773	- - -
8.20	.729	.0687	.0016	.006	2.553	.185
8.20	.736	.0579	.0109	.020	2.352	.385
8.20	.740	.0452	.0153	.036	2.115	.546
8.20	.746	.0369	.0188	.047	2.005	.608
a9.19	.731	.0951	-.0059	- - -	- - -	- - -
9.20	.767	.0951	.0138	-.005	2.764	- - -
9.20	.784	.0879	.0184	.005	2.508	.190
9.21	.794	.0773	.0254	.020	2.346	.398
9.21	.796	.0687	.0261	.037	2.187	.547
9.21	.798	.0610	.0268	.047	2.006	.606
a10.19	.771	.1165	.0005	- - -	- - -	- - -
10.20	.804	.1177	.0271	-.006	2.796	- - -
10.21	.819	.1102	.0285	.005	2.600	.199
10.22	.836	.1013	.0373	.020	2.348	.408
10.22	.849	.0909	.0445	.038	2.125	.574
10.22	.853	.0847	.0433	.046	2.028	.607

M, 0.83						
α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
a2.05	0.182	0.0251	-0.0449	- - -	- - -	- - -
2.05	.176	.0291	-.0729	-0.004	2.733	- - -
2.04	.172	.0203	-.0660	.007	2.548	0.181
2.04	.171	.0086	-.0528	.028	2.204	.444
2.04	.170	-.0052	-.0462	.037	2.078	.514
2.04	.170	-.0167	-.0400	.050	1.895	.586
a3.08	.289	.0259	-.0467	- - -	- - -	- - -
3.08	.286	.0299	-.0666	-.004	2.737	- - -
3.08	.283	.0203	-.0574	.007	2.543	.191
3.08	.286	.0063	-.0489	.024	2.257	.411
3.08	.288	-.0074	-.0408	.039	2.052	.551
3.08	.290	-.0140	-.0362	.050	1.909	.589
a4.11	.399	.0297	-.0430	- - -	- - -	- - -
4.11	.397	.0330	-.0610	-.003	2.735	- - -
4.11	.395	.0237	-.0516	.007	2.544	.190
4.11	.400	.0105	-.0420	.024	2.269	.413
4.11	.402	-.0006	-.0339	.038	2.075	.551
4.11	.407	-.0107	-.0281	.049	1.985	.597
a5.14	.497	.0307	-.0418	- - -	- - -	- - -
5.14	.499	.0407	-.0534	-.003	2.736	- - -
5.14	.500	.0318	-.0460	.007	2.548	.190
5.14	.509	.0180	-.0361	.024	2.271	.420
5.14	.512	.0073	-.0302	.038	2.067	.531
5.14	.515	-.0018	-.0262	.049	1.934	.599
a6.16	.573	.0528	-.0362	- - -	- - -	- - -
6.16	.587	.0587	-.0439	-.003	2.749	- - -
6.16	.592	.0454	-.0371	.008	2.551	.192
6.16	.594	.0299	-.0269	.025	2.272	.428
6.17	.598	.0191	-.0204	.040	2.077	.543
6.17	.611	.0119	-.0123	.049	1.946	.597
a7.17	.635	.0671	-.0241	- - -	- - -	- - -
7.18	.659	.0696	-.0254	-.004	2.737	- - -
7.18	.665	.0594	-.0170	.007	2.560	.199
7.18	.667	.0466	-.0103	.025	2.267	.428
7.18	.673	.0361	-.0048	.040	2.078	.550
7.19	.680	.0292	-.0016	.049	1.959	.603
a8.18	.686	.0876	-.0088	- - -	- - -	- - -
8.19	.719	.0861	-.0068	-.004	2.771	- - -
8.19	.727	.0784	-.0005	.007	2.585	.200
8.20	.735	.0676	.0066	.024	2.276	.435
8.20	.744	.0569	.0132	.039	2.087	.570
8.20	.775	.0487	.0171	.048	1.964	.602
a9.19	.732	.1053	-.0081	- - -	- - -	- - -
9.20	.765	.1077	.0017	-.004	2.780	- - -
9.21	.785	.1000	.0160	.006	2.578	.202
9.21	.802	.0881	.0274	.024	2.281	.436
9.21	.806	.0789	.0328	.039	2.088	.572
9.22	.815	.0716	.0333	.047	1.964	.604
a10.18	.775	.1267	.0088	- - -	- - -	- - -
10.20	.804	.1251	.0281	-.005	2.796	- - -
10.21	.810	.1203	.0292	.006	2.528	.213
10.21	.832	.1101	.0342	.024	2.263	.443
10.22	.837	.1083	.0331	.038	2.105	.568
10.22	.859	.0959	.0313	.047	1.976	.602

aProps off.

NACA

TABLE VI.- LONGITUDINAL CHARACTERISTICS OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10; TAIL OFF, $\beta = 51^\circ$, R = 1,000,000 - Concluded

(b) M = 0.86, 0.90

M, 0.86							M, 0.90						
α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	CP_{av}	α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	CP_{av}
[a]2.06	0.196	0.0282	-0.0439	---	---	---	[a]2.06	0.197	0.0368	-0.0441	---	---	---
2.05	.182	.0305	-.0734	-0.005	2.743	---	2.06	.198	.0401	-.0849	-0.005	2.708	---
2.05	.183	.0224	-.0639	.006	2.547	0.178	2.05	.194	.0332	-.0759	.003	2.542	0.187
2.05	.183	.0140	-.0576	.017	2.353	.325	2.05	.194	.0221	-.0657	.015	2.286	.321
2.05	.182	.0038	-.0474	.029	2.148	.451	2.05	.193	.0091	-.0543	.027	2.034	.432
2.05	.181	-.0066	-.0417	.041	1.964	.560	2.05	.192	.0034	-.0505	.035	1.878	.468
[a]3.07	.305	.0304	-.0474	---	---	---	[a]3.08	.286	.0413	-.0478	---	---	---
3.08	.297	.0324	-.0707	-.005	2.750	---	3.08	.296	.0474	-.0895	-.005	2.716	---
3.08	.299	.0249	-.0633	.006	2.557	.176	3.08	.300	.0382	-.0778	.003	2.542	.158
3.08	.301	.0160	-.0568	.017	2.360	.329	3.09	.306	.0266	-.0715	.015	2.291	.332
3.08	.303	.0059	-.0474	.029	2.162	.458	3.09	.306	.0197	-.0665	.026	2.067	.426
3.08	.302	-.0053	-.0417	.042	1.975	.539	3.09	.309	.0091	-.0616	.035	1.891	.473
[a]4.11	.406	.0371	-.0484	---	---	---	[a]4.10	.373	.0503	-.0539	---	---	---
4.10	.411	.0384	-.0686	-.004	2.748	---	4.11	.386	.0566	-.0849	-.005	2.786	---
4.12	.413	.0311	-.0614	.006	2.555	.184	4.11	.387	.0473	-.0734	.004	2.549	.160
4.12	.418	.0219	-.0528	.017	2.362	.343	4.11	.393	.0360	-.0682	.015	2.303	.333
4.12	.422	.0108	-.0450	.029	2.160	.478	4.11	.400	.0253	-.0618	.027	2.056	.436
4.12	.425	.0010	-.0401	.041	1.984	.551	4.11	.401	.0199	-.0593	.035	1.897	.479
[a]5.14	.492	.0485	-.0456	---	---	---	[a]5.12	.451	.0632	-.0494	---	---	---
5.14	.505	.0486	-.0632	-.004	2.754	---	5.13	.465	.0667	-.0684	-.004	2.734	---
5.14	.506	.0414	-.0547	.006	2.560	.186	5.12	.463	.0596	-.0686	.004	2.558	.163
5.14	.510	.0318	-.0477	.018	2.355	.355	5.13	.473	.0485	-.0569	.015	2.310	.341
5.14	.512	.0230	-.0428	.030	2.159	.477	5.13	.481	.0374	-.0506	.027	2.061	.452
5.14	.517	.0128	-.0380	.042	1.982	.554	5.14	.485	.0312	-.0484	.034	1.987	.480
[a]6.15	.562	.0628	-.0397	---	---	---	[a]6.14	.521	.0761	-.0433	---	---	---
6.16	.583	.0625	-.0485	-.004	2.761	---	6.14	.528	.0821	-.0577	-.004	2.749	---
6.16	.586	.0562	-.0409	.006	2.567	.187	6.14	.535	.0745	-.0493	.005	2.555	.173
6.16	.587	.0476	-.0361	.018	2.368	.349	6.15	.545	.0643	-.0487	.016	2.320	.345
6.16	.593	.0373	-.0297	.030	2.166	.400	6.15	.555	.0532	-.0374	.028	2.082	.453
6.17	.599	.0276	-.0252	.042	1.990	.559	6.15	.561	.0495	-.0348	.035	1.983	.490
[a]7.16	.623	.0784	-.0278	---	---	---	[a]7.15	.584	.0934	-.0337	---	---	---
7.18	.651	.0800	-.0315	-.004	2.764	---	7.16	.607	.0976	-.0435	-.004	2.795	---
7.18	.650	.0737	-.0258	.006	2.571	.191	7.16	.608	.0924	-.0380	.005	2.565	.175
7.18	.653	.0645	-.0197	.017	2.375	.323	7.16	.617	.0807	-.0312	.017	2.310	.356
7.18	.659	.0540	-.0136	.029	2.180	.462	7.16	.624	.0743	-.0279	.025	2.186	.445
7.18	.665	.0456	-.0112	.042	1.998	.561	7.17	.630	.0664	-.0250	.034	1.949	.496
[a]8.18	.675	.0967	-.0177	---	---	---	[a]8.17	.649	.1101	-.0268	---	---	---
8.19	.704	.0966	-.0137	-.004	2.782	---	8.17	.664	.1161	-.0291	-.004	2.767	---
8.19	.716	.0919	-.0091	.007	2.578	.197	8.18	.676	.1119	-.0241	.005	2.566	.181
8.19	.720	.0834	-.0025	.018	2.370	.364	8.18	.683	.1013	-.0195	.017	2.324	.354
8.19	.727	.0742	.0020	.031	2.172	.488	8.18	.691	.0976	-.0154	.025	2.130	.448
8.20	.735	.0660	.0064	.042	2.004	.569	8.19	.697	.0869	-.0124	.034	1.956	.503
[a]9.19	.725	.1169	-.0074	---	---	---	[a]9.18	.698	.1322	-.0162	---	---	---
9.19	.754	.1175	.0014	-.005	2.792	---	9.18	.721	.1387	-.0123	-.005	2.779	---
9.20	.773	.1133	.0057	.006	2.589	.195	9.19	.737	.1332	-.0119	.005	2.578	.182
9.20	.782	.1034	.0126	.018	2.380	.362	9.19	.748	.1261	-.0042	.017	2.328	.364
9.21	.791	.0969	.0172	.031	2.175	.498	9.19	.754	.1156	-.0007	.026	2.129	.465
9.21	.798	.0879	.0216	.042	2.013	.570	9.20	.759	.1119	.0023	.034	1.963	.499
[a]10.18	.752	.1379	.0007	---	---	---	[a]10.18	.750	.1597	-.0008	---	---	---
10.20	.800	.1415	.0202	-.005	2.812	---	10.20	.785	.1659	.0059	-.005	2.802	---
10.21	.819	.1354	.0266	.007	2.590	.202	10.21	.807	.1548	.0081	.006	2.565	.200
10.22	.837	.1292	.0339	.019	2.380	.376	10.21	.816	.1508	.0128	.018	2.324	.378
10.22	.847	.1227	.0380	.030	2.196	.488	10.21	.819	.1412	.0167	.026	2.145	.468
10.22	.855	.1121	.0415	.042	2.035	.566	10.21	.824	.1388	.0216	.034	1.986	.516

[a]Props off.

TABLE VII.- LONGITUDINAL CHARACTERISTICS OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10; TAIL HEIGHT = 0 b/2, $i_t = -4^{\circ}$, $\beta = 51^{\circ}$, R = 2,000,000

M = 0.70, 0.80, 0.90

M, 0.70						
α	C_L	C_X	C_m	$T_{C_{av}}$	ϵ_{av}	$C_{P_{av}}$
[a]2.05	0.133	0.0197	0.0453	---	---	---
2.05	.132	.0219	.0238	-0.001	2.783	---
2.05	.132	.0189	.0258	.002	2.704	0.079
2.05	.121	.0115	.0328	.011	2.550	.236
2.05	.120	.0038	.0410	.021	2.403	.378
2.05	.119	-.0018	.0457	.026	2.320	.450
[a]3.06	.233	.0303	.0243	---	---	---
3.05	.226	.0284	.0104	-.001	2.776	---
3.06	.225	.0197	.0130	.001	2.709	.070
3.05	.224	.0126	.0193	.010	2.559	.209
3.05	.224	.0047	.0257	.020	2.422	.373
3.05	.224	-.0001	.0292	.028	2.301	.429
[a]4.08	.331	.0318	.0076	---	---	---
4.06	.336	.0238	-.0008	-.001	2.776	---
4.06	.334	.0216	.0009	0	2.722	.056
4.08	.335	.0140	.0069	.011	2.574	.229
4.08	.338	.0061	.0114	.020	2.415	.372
4.08	.339	.0004	.0145	.027	2.324	.459
[a]5.11	.431	.0247	-.0103	---	---	---
5.11	.425	.0266	-.0141	-.001	2.776	---
5.11	.425	.0244	-.0142	.002	2.708	.059
5.11	.427	.0175	-.0099	.010	2.564	.210
5.11	.430	.0088	-.0049	.021	2.410	.389
5.11	.433	.0040	-.0035	.026	2.343	.447
[a]6.14	.527	.0285	-.0287	---	---	---
6.14	.524	.0303	-.0293	-.001	2.760	---
6.14	.524	.0282	-.0277	.001	2.718	.050
6.14	.527	.0214	-.0254	.010	2.570	.216
6.14	.532	.0125	-.0203	.022	2.415	.389
6.14	.535	.0083	-.0185	.026	2.347	.453
[a]7.16	.621	.0346	-.0473	---	---	---
7.16	.620	.0360	-.0481	-.001	2.780	---
7.16	.619	.0333	-.0398	.001	2.780	.064
7.16	.624	.0270	-.0366	.010	2.771	.220
7.17	.629	.0214	-.0354	.018	2.460	.347
7.17	.632	.0147	-.0309	.027	2.345	.459
[a]8.19	.710	.0447	-.0524	---	---	---
8.19	.716	.0448	-.0519	-.001	2.788	---
8.19	.715	.0405	-.0513	.002	2.721	.067
8.19	.720	.0354	-.0480	.010	2.566	.240
8.19	.723	.0308	-.0463	.016	2.470	.333
8.20	.728	.0249	-.0480	.025	2.348	.451
[a]9.20	.774	.0633	-.0785	---	---	---
9.21	.798	.0588	-.0610	-.001	2.799	---
9.21	.800	.0562	-.0583	.002	2.719	.080
9.22	.806	.0498	-.0561	.011	2.575	.243
9.22	.809	.0435	-.0530	.017	2.477	.337
9.22	.815	.0393	-.0495	.025	2.348	.458
[a]10.21	.831	.0846	-.0916	---	---	---
10.23	.866	.0801	-.0633	-.002	2.804	---
10.22	.864	.0777	-.0598	.002	2.732	.066
10.23	.869	.0732	-.0575	.004	2.579	.258
10.23	.875	.0671	-.0533	.018	2.465	.379
10.23	.881	.0617	-.0709	.025	2.352	.474

M, 0.80						
α	C_L	C_X	C_m	$T_{C_{av}}$	ϵ_{av}	$C_{P_{av}}$
[a]2.03	0.139	0.0221	0.0444	---	---	---
2.03	.128	.0255	.0214	-0.001	2.738	---
2.03	.129	.0205	.0264	.001	2.638	0.111
2.03	.128	.0160	.0317	.007	2.583	.213
2.03	.128	.0109	.0376	.013	2.434	.304
2.03	.127	.0046	.0431	.020	2.323	.398
[a]3.06	.249	.0298	.0242	---	---	---
3.06	.240	.0258	.0094	-.001	2.748	---
3.06	.241	.0213	.0136	.001	2.643	.105
3.06	.241	.0161	.0186	.007	2.583	.215
3.06	.241	.0120	.0231	.012	2.479	.292
3.06	.242	.0047	.0286	.021	2.318	.404
[a]4.10	.357	.0245	-.0081	---	---	---
4.09	.351	.0277	-.0026	0	2.742	---
4.09	.351	.0230	.0018	.001	2.651	.103
4.09	.353	.0192	.0058	.006	2.560	.195
4.09	.354	.0138	.0107	.012	2.450	.293
4.10	.356	.0068	.0148	.020	2.322	.407
[a]5.13	.469	.0291	-.0183	---	---	---
5.12	.462	.0318	-.0237	0	2.744	---
5.12	.467	.0278	-.0153	.001	2.651	.106
5.12	.469	.0229	-.0128	.006	2.552	.202
5.12	.471	.0182	-.0087	.012	2.458	.293
5.12	.473	.0115	-.0046	.020	2.328	.403
[a]6.16	.574	.0383	-.0392	---	---	---
6.16	.577	.0397	-.0369	-.001	2.752	---
6.16	.577	.0374	-.0333	.002	2.651	.108
6.16	.579	.0307	-.0321	.008	2.561	.197
6.16	.582	.0258	-.0292	.013	2.448	.310
6.16	.585	.0199	-.0272	.021	2.334	.401
[a]7.18	.672	.0589	-.0497	---	---	---
7.19	.676	.0583	-.0485	-.001	2.732	---
7.19	.679	.0481	-.0474	.001	2.668	.109
7.19	.680	.0441	-.0430	.006	2.577	.200
7.19	.682	.0402	-.0408	.012	2.471	.293
7.19	.684	.0347	-.0380	.020	2.354	.395
[a]8.19	.710	.0705	-.0473	---	---	---
8.20	.747	.0698	-.0430	-.002	2.769	---
8.20	.744	.0659	-.0410	.001	2.672	.108
8.20	.749	.0618	-.0393	.006	2.572	.210
8.21	.756	.0572	-.0382	.013	2.462	.313
8.21	.759	.0520	-.0360	.019	2.359	.400
[a]9.20	.760	.0902	-.0527	---	---	---
9.21	.802	.0904	-.0564	-.002	2.784	---
9.21	.804	.0864	-.0372	.001	2.693	.104
9.22	.813	.0847	-.0337	.007	2.576	.213
9.22	.822	.0802	-.0341	.013	2.477	.311
9.22	.827	.0786	-.0318	.020	2.363	.408
[a]10.21	.808	.1143	-.0815	---	---	---
10.22	.845	.1142	-.0377	-.005	2.785	---
10.22	.853	.1097	-.0359	.001	2.684	.182
10.22	.860	.1040	-.0372	.006	2.591	.202
10.23	.868	.1017	-.0396	.013	2.478	.318
10.23	.874	.0980	-.0380	.019	2.365	.402

M, 0.90						
α	C_L	C_X	C_m	$T_{C_{av}}$	ϵ_{av}	$C_{P_{av}}$
[a]2.05	0.177	0.0348	0.0344	---	---	---
2.04	.161	.0361	.0058	-0.005	2.718	---
2.04	.157	.0348	.0127	-.005	2.661	0.061
2.04	.153	.0286	.0189	.004	2.509	.177
2.04	.152	.0211	.0286	.012	2.346	.296
2.04	.151	.0195	.0352	.016	2.287	.388
[a]3.07	.265	.0375	.0144	---	---	---
3.07	.277	.0410	-.0221	-.005	2.728	---
3.07	.276	.0387	-.0162	-.003	2.662	.054
3.07	.275	.0327	-.0096	.004	2.518	.184
3.07	.275	.0272	-.0010	.010	2.356	.261
3.07	.275	.0230	.0027	.015	2.299	.333
[a]4.10	.368	.0454	-.0112	---	---	---
4.10	.369	.0495	-.0492	-.005	2.723	---
4.11	.368	.0467	-.0465	-.003	2.689	.048
4.11	.369	.0418	-.0413	.004	2.533	.181
4.11	.391	.0340	-.0346	.011	2.377	.295
4.11	.391	.0326	-.0336	.015	2.311	.333
[a]5.12	.478	.0583	-.0289	---	---	---
5.13	.484	.0615	-.0617	-.004	2.737	---
5.13	.476	.0620	-.0623	-.003	2.659	.051
5.13	.476	.0518	-.0513	.005	2.530	.195
5.13	.474	.0463	-.0458	.016	2.365	.291
5.13	.474	.0444	-.0445	.015	2.320	.347
[a]6.14	.582	.0735	-.0836	---	---	---
6.15	.566	.0738	-.0571	-.004	2.743	---
6.15	.566	.0745	-.0548	-.002	2.710	.052
6.15	.570	.0679	-.0510	.004	2.549	.200
6.15	.568	.0642	-.0506	.012	2.389	.307
6.15	.571	.0601	-.0504	.014	2.337	.342
[a]7.16	.597	.0899	-.0488	---	---	---
7.16	.617	.0913	-.0575	-.004	2.751	---
7.16	.617	.0889	-.0569	-.002	2.709	.063
7.16	.622	.0846	-.0536	.005	2.552	.200
7.16	.623	.0802	-.0533	.011	2.425	.305
7.17	.626	.0765	-.0532	.015	2.339	.350
[a]8.17	.659	.1060	-.0592	---	---	---
8.18	.691	.1105	-.0645	-.004	2.768	---
8.18	.690	.1068	-.0635	-.003	2.728	.057
8.18	.691	.1043	-.0628	.003	2.554	.176
8.18	.695	.0994	-.0596	.010	2.456	.266
8.18	.697	.0997	-.0581	.015	2.354	.344
[a]9.19	.786	.1271	-.0796	---	---	---
9.20	.757	.1318	-.0731	-.005	2.792	---
9.20	.759	.1300	-.0721	-.001	2.718	.062
9.20	.761	.1290	-.0699	.005	2.576	.210
9.20	.766	.1161	-.0640	.010	2.463	.294
9.20	.767	.1158	-.0663	.015	2.373	.348
[a]10.20	.790	.1555	-.0999	---	---	---
10.21	.828	.1602	-.0073	-.005	2.807	---
10.21	.827	.1609	-.0908	-.002	2.747	.069
10.21	.831	.1499	-.0764	.005	2.583	.210
10.21	.850	.1482	-.0805	.011	2.474	.295
10.22	.839	.1414	-.0744	.015	2.356	.368

[a]Props off.

TABLE VIII.- LONGITUDINAL CHARACTERISTICS OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10; TAIL OFF, $\beta = 51^{\circ}$, R = 2,000,000 M = 0.70, 0.80, 0.90

M, 0.70

α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
[a]2.04	0.161	0.0179	-0.0452	- - -	- - -	- - -
2.04	.154	.0209	-.0676	-0.003	2.770	- - -
2.04	.152	.0143	-.0613	.006	2.680	0.160
2.04	.151	.0091	-.0574	.012	2.528	.260
2.04	.150	.0048	-.0537	.017	2.435	.348
2.04	.149	-.0023	-.0467	.027	2.296	.446
[a]3.07	.247	.0187	-.0486	- - -	- - -	- - -
3.06	.248	.0215	-.0580	-.003	2.769	- - -
3.06	.245	.0158	-.0528	.005	2.631	.153
3.06	.246	.0107	-.0491	.011	2.536	.243
3.06	.245	.0041	-.0443	.019	2.420	.352
3.06	.246	-.0019	-.0408	.026	2.319	.448
[a]4.09	.345	.0207	-.0389	- - -	- - -	- - -
4.09	.339	.0231	-.0486	-.008	2.771	- - -
4.09	.340	.0174	-.0433	.005	2.632	.138
4.09	.340	.0126	-.0408	.011	2.541	.234
4.09	.341	.0061	-.0362	.019	2.432	.329
4.09	.343	-.0007	-.0307	.027	2.321	.420
[a]5.12	.435	.0233	-.0337	- - -	- - -	- - -
5.11	.432	.0258	-.0367	-.002	2.769	- - -
5.12	.432	.0208	-.0332	.005	2.636	.138
5.11	.434	.0126	-.0305	.011	2.544	.228
5.12	.436	.0088	-.0245	.019	2.436	.337
5.12	.439	.0025	-.0199	.027	2.329	.435
[a]6.14	.524	.0270	-.0281	- - -	- - -	- - -
6.14	.522	.0298	-.0266	-.008	2.771	- - -
6.14	.525	.0257	-.0244	.005	2.673	.134
6.14	.524	.0192	-.0207	.011	2.541	.232
6.14	.528	.0132	-.0151	.019	2.445	.328
6.14	.531	.0065	-.0103	.026	2.332	.439
[a]7.16	.611	.0325	-.0222	- - -	- - -	- - -
7.16	.612	.0345	-.0192	-.002	2.773	- - -
7.16	.613	.0292	-.0145	.005	2.648	.136
7.16	.615	.0243	-.0114	.011	2.548	.248
7.16	.619	.0191	-.0039	.018	2.443	.350
7.16	.622	.0124	-.0010	.027	2.333	.429
[a]8.18	.698	.0417	-.0147	- - -	- - -	- - -
8.19	.700	.0430	-.0086	-.002	2.775	- - -
8.19	.703	.0375	-.0033	.004	2.648	.149
8.19	.705	.0327	-.0014	.011	2.545	.257
8.19	.709	.0284	.0015	.017	2.451	.352
8.19	.712	.0227	.0030	.025	2.338	.454
[a]9.19	.770	.0597	-.0109	- - -	- - -	- - -
9.20	.778	.0568	.0041	-.002	2.787	- - -
9.20	.783	.0503	.0091	.006	2.638	.170
9.21	.788	.0463	.0127	.012	2.548	.270
9.21	.780	.0424	.0160	.017	2.454	.356
9.21	.793	.0372	.0204	.025	2.345	.453
[a]10.21	.806	.0803	-.0007	- - -	- - -	- - -
10.22	.840	.0769	.0105	-.003	2.808	- - -
10.22	.841	.0715	.0257	.005	2.651	.171
10.22	.845	.0678	.0307	.011	2.554	.269
10.22	.851	.0634	.0334	.018	2.454	.361
10.22	.857	.0582	.0377	.025	2.348	.439

M, 0.80

α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
[a]2.04	0.167	0.0207	-0.0478	- - -	- - -	- - -
2.04	.155	.0248	-.0711	-0.004	2.744	- - -
2.04	.154	.0190	-.0677	.001	2.648	0.103
2.04	.153	.0131	-.0616	.009	2.525	.248
2.04	.153	.0078	-.0570	.015	2.395	.342
2.04	.153	.0050	-.0544	.020	2.383	.400
[a]3.07	.259	.0211	-.0474	- - -	- - -	- - -
3.07	.258	.0246	-.0631	-.004	2.769	- - -
3.07	.261	.0212	-.0595	.001	2.460	.091
3.07	.262	.0136	-.0527	.009	2.511	.233
3.07	.263	.0092	-.0487	.015	2.415	.325
3.07	.264	.0037	-.0437	.021	2.316	.407
[a]4.10	.369	.0234	-.0483	- - -	- - -	- - -
4.10	.365	.0282	-.0538	-.004	2.755	- - -
4.10	.365	.0234	-.0408	0	2.671	.082
4.10	.366	.0156	-.0419	.009	2.509	.246
4.10	.369	.0113	-.0377	.015	2.416	.330
4.10	.368	.0063	-.0368	.020	2.339	.399
[a]5.13	.473	.0276	-.0390	- - -	- - -	- - -
5.13	.472	.0310	-.0463	-.004	2.748	- - -
5.13	.473	.0271	-.0416	0	2.665	.093
5.13	.476	.0206	-.0358	.009	2.519	.297
5.13	.477	.0157	-.0317	.014	2.423	.388
5.13	.478	.0106	-.0286	.020	2.327	.405
[a]6.16	.573	.0366	-.0330	- - -	- - -	- - -
6.16	.576	.0388	-.0405	-.004	2.735	- - -
6.16	.577	.0352	-.0372	0	2.676	.083
6.16	.578	.0287	-.0303	.008	2.533	.231
6.16	.581	.0237	-.0259	.015	2.419	.368
6.16	.582	.0197	-.0219	.020	2.333	.409
[a]7.18	.648	.0500	-.0299	- - -	- - -	- - -
7.18	.668	.0521	-.0304	-.004	2.765	- - -
7.18	.670	.0477	-.0278	.001	2.684	.091
7.18	.672	.0405	-.0213	.009	2.524	.246
7.18	.672	.0351	-.0164	.016	2.407	.350
7.18	.672	.0325	-.0159	.021	2.338	.406
[a]8.19	.700	.0679	-.0160	- - -	- - -	- - -
8.20	.732	.0676	-.0099	-.004	2.770	- - -
8.20	.730	.0621	-.0079	0	2.696	.081
8.20	.739	.0587	-.0038	.010	2.529	.250
8.20	.742	.0525	0	.017	2.401	.360
8.20	.745	.0499	.0018	.021	2.348	.414
[a]9.19	.743	.0882	-.0024	- - -	- - -	- - -
9.21	.784	.0882	.0115	-.004	2.766	- - -
9.21	.780	.0849	.0127	.008	2.677	.139
9.21	.798	.0783	.0174	.010	2.553	.259
9.18	.801	.0719	.0205	.017	2.421	.358
9.21	.807	.0704	.0241	.021	2.356	.409
[a]10.19	.782	.1091	-.0045	- - -	- - -	- - -
10.21	.823	.1117	.0278	-.004	2.795	- - -
10.21	.828	.1070	.0304	.001	2.695	.113
10.22	.838	.1007	.0304	.009	2.533	.287
10.22	.845	.0965	.0327	.015	2.447	.350
10.22	.851	.0952	.0361	.020	2.387	.415

M, 0.90

α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
[a]2.06	0.208	0.0372	-0.0637	- - -	- - -	- - -
2.05	.188	.0361	-.0803	-0.005	2.786	- - -
2.05	.186	.0324	-.0765	-.001	2.680	0.090
2.05	.183	.0272	-.0702	.005	2.508	.187
2.05	.182	.0208	-.0639	.012	2.368	.292
2.05	.181	.0181	-.0604	.016	2.276	.343
[a]3.08	.283	.0374	-.0568	- - -	- - -	- - -
3.08	.297	.0402	-.0878	-.005	2.787	- - -
3.08	.297	.0354	-.0838	-.001	2.638	.089
3.08	.297	.0311	-.0766	.005	2.518	.198
3.08	.298	.0254	-.0726	.011	2.377	.291
3.08	.299	.0212	-.0683	.016	2.292	.347
[a]4.10	.376	.0460	-.0630	- - -	- - -	- - -
4.11	.402	.0486	-.0923	-.004	2.743	- - -
4.11	.401	.0448	-.0897	-.001	2.665	.074
4.11	.402	.0407	-.0855	.005	2.535	.183
4.11	.403	.0333	-.0818	.010	2.426	.267
4.11	.407	.0290	-.0776	.016	2.305	.336
[a]5.18	.443	.0639	-.0663	- - -	- - -	- - -
5.14	.486	.0631	-.0881	-.004	2.749	- - -
5.14	.487	.0572	-.0834	0	2.662	.088
5.14	.485	.0506	-.0764	.005	2.537	.186
5.13	.484	.0463	-.0741	.010	2.423	.281
5.13	.482	.0448	-.0717	.016	2.319	.345
[a]6.13	.518	.0768	-.0779	- - -	- - -	- - -
6.15	.551	.0764	-.0744	-.004	2.735	- - -
6.15	.554	.0713	-.0683	0	2.666	.091
6.15	.554	.0654	-.0632	.009	2.548	.200
6.15	.555	.0610	-.0593	.010	2.438	.286
6.15	.558	.0540	-.0585	.016	2.389	.353
[a]7.15	.582	.0919	-.0498	- - -	- - -	- - -
7.16	.614	.0983	-.0530	-.004	2.776	- - -
7.16	.617	.0864	-.0505	0	2.680	.090
7.16	.614	.0815	-.0465	.005	2.524	.187
7.16	.615	.0781	-.0466	.011	2.438	.278
7.16	.620	.0743	-.0399	.016	2.337	.351
[a]8.17	.649	.1092	-.0399	- - -	- - -	- - -
8.18	.680	.1112	-.0386	-.004	2.784	- - -
8.18	.683	.1053	-.0365	0	2.687	.095
8.18	.685	.1010	-.0323	.005	2.566	.202
8.18	.687	.0954	-.0283	.010	2.465	.285
8.18	.687	.0906	-.0259	.016	2.336	.363
[a]9.18	.700	.1346	-.0287	- - -	- - -	- - -
9.19	.741	.1343	-.0238	-.005	2.798	- - -
9.19	.743	.1271	-.0202	0	2.686	.108
9.19	.746	.1211	-.0164	.005	2.569	.211
9.19	.749	.1184	-.0125	.010	2.462	.289
9.19	.749	.1114	-.0094	.016	2.359	.354
[a]10.19	.765	.1581	-.0186	- - -	- - -	- - -
10.21	.806	.1573	-.0066	-.005	2.810	- - -
10.21	.805	.1501	-.0009	0	2.698	.118
10.21	.806	.1441	.0026	.005	2.576	.215
10.21	.808	.1404	.0058	.010	2.478	.296
10.21	.819	.1378	.0071	.016	2.350	.371

[a]Props off.

TABLE IX.- LONGITUDINAL CHARACTERISTICS OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10; TAIL HEIGHT = 0 b/2, $i_t = -4^{\circ}$, $\beta = 41^{\circ}$, R = 2,000,000

M = 0.60, 0.70, 0.80

M, 0.60						
α	C_L	C_X	C_m	$T_{C_{av}}$	J_{av}	CP_{av}
[a]2.04	0.159	0.0174	-0.0429	- - -	- - -	- - -
2.03	.123	.0220	.0306	-0.003	1.953	- - -
2.03	.123	.0155	.0340	.004	1.872	0.055
2.03	.121	.0049	.0423	.019	1.774	.141
2.03	.119	-.0069	.0516	.034	1.677	.220
2.03	.117	-.0210	.0594	.049	1.599	.280
[a]3.06	.247	.0182	-.0363	- - -	- - -	- - -
3.05	.219	.0224	.0157	-.009	1.931	- - -
3.05	.220	.0117	.0235	.011	1.830	.068
3.05	.220	.0072	.0277	.018	1.777	.134
3.05	.220	-.0090	.0351	.035	1.678	.221
3.05	.220	-.0204	.0402	.049	1.602	.278
[a]4.09	.332	.0197	-.0369	- - -	- - -	- - -
4.08	.315	.0238	.0086	-.003	1.930	- - -
4.08	.318	.0134	.0083	.009	1.831	.066
4.08	.320	.0063	.0116	.018	1.776	.137
4.08	.323	-.0070	.0179	.034	1.661	.220
4.08	.325	-.0189	.0208	.048	1.606	.278
[a]5.11	.418	.0222	-.0307	- - -	- - -	- - -
5.10	.410	.0259	-.0229	-.005	1.929	- - -
5.10	.413	.0164	-.0067	.006	1.842	.080
5.11	.415	.0096	-.0045	.017	1.783	.129
5.11	.421	-.0051	.0011	.034	1.685	.224
5.11	.424	-.0156	.0047	.047	1.617	.274
[a]6.15	.502	.0253	-.0242	- - -	- - -	- - -
6.13	.502	.0290	-.0269	-.003	1.932	- - -
6.13	.508	.0212	-.0226	.006	1.872	.066
6.13	.512	.0126	-.0202	.016	1.786	.130
6.14	.520	-.0013	-.0151	.034	1.685	.221
6.14	.529	-.0120	-.0118	.048	1.612	.276
[a]7.15	.584	.0291	-.0206	- - -	- - -	- - -
7.15	.584	.0336	-.0404	-.005	1.936	- - -
7.16	.597	.0257	-.0360	.006	1.882	.067
7.16	.605	.0178	-.0343	.016	1.791	.130
7.16	.618	.0039	-.0296	.034	1.684	.220
7.16	.620	-.0069	-.0254	.048	1.612	.278
[a]8.17	.663	.0346	-.0115	- - -	- - -	- - -
8.18	.685	.0396	-.0507	-.005	1.933	- - -
8.18	.693	.0317	-.0496	.009	1.838	.087
8.19	.699	.0227	-.0471	.020	1.774	.150
8.19	.711	.0094	-.0435	.036	1.673	.230
8.19	.718	.0006	-.0408	.049	1.611	.278
[a]9.19	.735	.0402	-.0011	- - -	- - -	- - -
9.20	.765	.0474	-.0597	-.003	1.942	- - -
9.20	.778	.0387	-.0573	.009	1.849	.087
9.21	.786	.0310	-.0541	.020	1.777	.149
9.21	.799	.0188	-.0485	.036	1.676	.232
9.22	.805	.0111	-.0463	.047	1.619	.275
[a]10.20	.798	.0509	.0102	- - -	- - -	- - -
10.22	.843	.0598	-.0674	-.003	1.952	- - -
10.22	.852	.0505	-.0684	.009	1.873	.089
10.22	.861	.0434	-.0575	.018	1.785	.158
10.23	.875	.0310	-.0522	.036	1.684	.237
10.23	.883	.0242	-.0483	.048	1.623	.278

M, 0.70						
α	C_L	C_X	C_m	$T_{C_{av}}$	J_{av}	CP_{av}
[a]2.04	0.161	0.0179	-0.0452	- - -	- - -	- - -
2.03	.127	.0236	.0276	-0.005	1.940	- - -
2.03	.125	.0159	.0340	.006	1.866	0.067
2.03	.124	.0072	.0414	.017	1.787	.131
2.03	.122	-.0013	.0480	.028	1.719	.186
2.03	.120	-.0117	.0550	.039	1.635	.245
[a]3.07	.255	.0187	-.0426	- - -	- - -	- - -
3.06	.228	.0241	.0156	-.004	1.939	- - -
3.06	.226	.0160	.0219	.006	1.862	.069
3.06	.226	.0074	.0275	.016	1.787	.138
3.06	.229	-.0008	.0331	.026	1.717	.187
3.06	.229	-.0100	.0373	.038	1.645	.237
[a]4.09	.345	.0207	-.0309	- - -	- - -	- - -
4.08	.327	.0261	.0084	-.004	1.942	- - -
4.08	.328	.0181	.0090	.006	1.867	.065
4.08	.330	.0095	.0130	.016	1.789	.125
4.08	.332	.0005	.0169	.026	1.716	.188
4.08	.334	-.0085	.0194	.038	1.643	.238
[a]5.12	.439	.0235	-.0537	- - -	- - -	- - -
5.11	.426	.0261	-.0123	-.004	1.943	- - -
5.11	.429	.0209	-.0081	.006	1.871	.052
5.11	.433	.0123	-.0059	.016	1.790	.125
5.12	.437	.0039	-.0002	.026	1.717	.187
5.12	.440	-.0050	.0005	.038	1.647	.238
[a]6.14	.524	.0270	-.0281	- - -	- - -	- - -
6.14	.524	.0316	-.0288	-.003	1.944	- - -
6.14	.529	.0241	-.0243	.006	1.866	.069
6.14	.533	.0168	-.0210	.016	1.793	.152
6.14	.538	.0076	-.0167	.026	1.717	.189
6.14	.543	-.0009	-.0143	.038	1.646	.239
[a]7.16	.611	.0325	-.0289	- - -	- - -	- - -
7.16	.619	.0373	-.0457	-.004	1.949	- - -
7.17	.625	.0297	-.0369	.006	1.870	.069
7.17	.630	.0221	-.0339	.016	1.796	.133
7.17	.638	.0138	-.0313	.027	1.716	.183
7.17	.644	.0058	-.0289	.038	1.647	.242
[a]8.18	.698	.0417	-.0147	- - -	- - -	- - -
8.18	.715	.0460	-.0576	-.004	1.952	- - -
8.19	.724	.0383	-.0520	.006	1.869	.073
8.20	.731	.0317	-.0480	.016	1.800	.131
8.20	.735	.0233	-.0456	.027	1.720	.188
8.20	.743	.0165	-.0422	.039	1.648	.238
[a]9.19	.750	.0397	-.0103	- - -	- - -	- - -
9.21	.802	.0596	-.0589	-.005	1.956	- - -
9.22	.811	.0523	-.0593	.007	1.871	.077
9.22	.816	.0456	-.0566	.016	1.799	.137
9.22	.823	.0376	-.0538	.027	1.719	.185
9.22	.826	.0311	-.0522	.038	1.661	.238
[a]10.21	.806	.0601	-.0007	- - -	- - -	- - -
10.22	.850	.0808	-.0682	-.005	1.982	- - -
10.22	.864	.0723	-.0609	.007	1.876	.081
10.23	.876	.0666	-.0574	.017	1.798	.148
10.24	.886	.0793	-.0588	.027	1.723	.197
10.24	.892	.0738	-.0700	.038	1.688	.239

M, 0.80						
α	C_L	C_X	C_m	$T_{C_{av}}$	J_{av}	CP_{av}
[a]2.04	0.167	0.0207	-0.0478	- - -	- - -	- - -
2.03	.138	.0266	.0240	-0.006	1.949	- - -
2.03	.134	.0208	.0303	.001	1.893	0.047
2.03	.133	.0120	.0373	.013	1.796	.116
2.03	.132	.0057	.0446	.022	1.727	.172
2.03	.131	-.0034	.0494	.031	1.668	.222
[a]3.07	.269	.0211	-.0474	- - -	- - -	- - -
3.06	.246	.0271	.0009	-.005	1.947	- - -
3.06	.245	.0236	.0144	-.002	1.907	.087
3.06	.246	.0131	.0233	.011	1.811	.115
3.06	.247	.0073	.0291	.020	1.743	.165
3.06	.248	-.0018	.0333	.029	1.685	.203
[a]4.10	.369	.0294	-.0423	- - -	- - -	- - -
4.10	.356	.0290	-.0005	-.005	1.949	- - -
4.10	.356	.0261	.0083	-.002	1.922	.025
4.10	.357	.0158	.0099	.010	1.823	.107
4.10	.360	.0075	.0139	.020	1.745	.165
4.10	.363	.0017	.0170	.026	1.691	.201
[a]5.13	.473	.0276	-.0390	- - -	- - -	- - -
5.13	.470	.0330	-.0182	-.005	1.947	- - -
5.13	.470	.0308	-.0150	-.003	1.931	.021
5.13	.471	.0207	-.0085	.009	1.838	.104
5.13	.476	.0128	-.0044	.019	1.752	.166
5.13	.477	.0062	-.0017	.026	1.699	.201
[a]6.16	.571	.0366	-.0370	- - -	- - -	- - -
6.16	.584	.0411	-.0367	-.005	1.954	- - -
6.16	.584	.0387	-.0362	-.003	1.936	.019
6.16	.588	.0294	-.0308	.010	1.839	.106
6.16	.590	.0210	-.0273	.020	1.756	.165
6.16	.592	.0148	-.0246	.027	1.701	.203
[a]7.18	.648	.0300	-.0299	- - -	- - -	- - -
7.19	.678	.0536	-.0471	-.005	1.961	- - -
7.19	.684	.0499	-.0474	-.002	1.958	.024
7.19	.687	.0422	-.0425	.009	1.880	.105
7.19	.689	.0363	-.0399	.020	1.773	.156
7.19	.690	.0298	-.0387	.028	1.708	.200
[a]8.19	.700	.0679	-.0160	- - -	- - -	- - -
8.20	.748	.0713	-.0419	-.005	1.987	- - -
8.20	.750	.0688	-.0409	-.002	1.939	.030
8.20	.733	.0620	-.0370	.010	1.844	.106
8.20	.754	.0559	-.0338	.020	1.767	.162
8.21	.758	.0492	-.0325	.027	1.718	.187
[a]9.19	.746	.0562	-.0024	- - -	- - -	- - -
9.21	.802	.0986	-.0397	-.005	1.973	- - -
9.22	.806	.0900	-.0574	-.003	1.949	.029
9.22	.816	.0846	-.0528	.010	1.845	.114
9.22	.825	.0773	-.0493	.020	1.767	.168
9.22	.830	.0700	-.0478	.028	1.716	.203
[a]10.39	.788	.1031	-.0045	- - -	- - -	- - -
10.22	.846	.1130	-.0433	-.006	1.984	- - -
10.22	.855	.1120	-.0378	-.001	1.948	.039
10.23	.868	.1038	-.0396	.011	1.848	.115
10.23	.868	.0970	-.0422	.020	1.777	.166
10.23	.874	.0942	-.0427	.026	1.718	.208

[a]Props off.

NACA

TABLE X.- LONGITUDINAL CHARACTERISTICS OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10; TAIL OFF, $\beta = 41^\circ$, R = 2,000,000 M = 0.60, 0.70, 0.80

M, 0.60

α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
a2.04	0.159	0.0174	-0.0489	---	---	---
2.04	.153	.0207	-.0686	-0.003	1.946	---
2.04	.158	.0085	-.0570	.009	1.889	0.103
2.04	.151	.0036	-.0517	.015	1.807	.139
2.04	.150	-.0096	-.0449	.031	1.707	.223
2.04	.149	-.0214	-.0405	.046	1.686	.277
a3.06	.247	.0182	-.0383	---	---	---
3.06	.241	.0214	-.0536	-.004	1.943	---
3.06	.241	.0128	-.0400	.009	1.845	.084
3.06	.248	.0039	-.0450	.018	1.786	.137
3.06	.248	-.0100	-.0575	.035	1.606	.224
3.06	.248	-.0203	-.0330	.048	1.618	.278
a4.09	.338	.0197	-.0569	---	---	---
4.08	.329	.0227	-.0448	-.003	1.948	---
4.08	.331	.0127	-.0383	.010	1.841	.065
4.08	.338	.0070	-.0351	.017	1.794	.127
4.08	.334	-.0083	-.0278	.034	1.691	.225
4.09	.336	-.0186	-.0234	.048	1.619	.273
a5.11	.418	.0222	-.0307	---	---	---
5.10	.414	.0249	-.0263	-.003	1.941	---
5.11	.419	.0154	-.0238	.009	1.843	.083
5.11	.422	.0095	-.0229	.018	1.797	.125
5.11	.426	-.0051	-.0192	.034	1.696	.219
5.11	.429	-.0165	-.0139	.047	1.621	.280
a6.13	.502	.0275	-.0242	---	---	---
6.13	.500	.0280	-.0276	-.005	1.943	---
6.13	.505	.0177	-.0210	.011	1.838	.089
6.13	.508	.0121	-.0180	.017	1.796	.129
6.14	.515	-.0029	-.0096	.035	1.691	.229
6.14	.518	-.0127	-.0056	.047	1.625	.277
a7.15	.584	.0291	-.0206	---	---	---
7.15	.585	.0383	-.0179	-.008	1.946	---
7.15	.589	.0233	-.0181	.009	1.852	.078
7.15	.592	.0158	-.0080	.017	1.792	.133
7.16	.601	.0027	-.0004	.034	1.698	.223
7.16	.607	-.0078	.0050	.047	1.625	.280
a8.17	.665	.0346	-.0115	---	---	---
8.17	.665	.0378	-.0078	-.003	1.946	---
8.17	.674	.0290	-.0011	.009	1.853	.083
8.18	.679	.0211	.0033	.018	1.798	.140
8.18	.689	.0087	.0068	.034	1.694	.226
8.19	.696	-.0009	.0157	.046	1.630	.277
a9.19	.735	.0429	-.0011	---	---	---
9.19	.741	.0432	.0047	-.005	1.951	---
9.19	.753	.0349	.0126	.010	1.849	.096
9.20	.758	.0260	.0169	.019	1.788	.151
9.20	.770	.0171	.0243	.034	1.697	.227
9.20	.777	.0088	.0291	.047	1.630	.278
a10.20	.798	.0569	.0208	---	---	---
10.21	.814	.0569	.0209	-.004	1.963	---
10.21	.823	.0478	.0278	.010	1.856	.095
10.21	.831	.0402	.0316	.019	1.795	.151
10.22	.844	.0290	.0386	.034	1.702	.238
10.22	.850	.0217	.0423	.046	1.648	.278

M, 0.70

α	C_L	C_X	C_m	$T_{c_{av.}}$	$J_{av.}$	$C_{P_{av}}$
a2.04	0.161	0.0179	-0.0452	---	---	---
2.04	.157	.0218	-.0689	-0.005	1.934	---
2.04	.156	.0174	-.0598	.001	1.893	0.041
2.04	.154	.0056	-.0519	.015	1.787	.138
2.04	.154	-.0056	-.0475	.028	1.691	.201
2.04	.155	-.0157	-.0486	.039	1.618	.251
a3.07	.255	.0187	-.0486	---	---	---
3.06	.250	.0222	-.0548	-.004	1.935	---
3.06	.251	.0186	-.0528	0	1.909	.033
3.06	.252	.0081	-.0458	.013	1.803	.119
3.06	.252	-.0047	-.0522	.028	1.697	.203
3.06	.253	-.0145	-.0549	.038	1.621	.252
a4.09	.345	.0207	-.0509	---	---	---
4.09	.348	.0240	-.0479	-.004	1.936	---
4.09	.343	.0211	-.0447	0	1.910	.039
4.09	.346	.0104	-.0377	.013	1.807	.116
4.09	.348	-.0082	-.0308	.027	1.705	.190
4.09	.350	-.0117	-.0275	.040	1.625	.247
a5.12	.435	.0235	-.0337	---	---	---
5.12	.435	.0267	-.0290	-.004	1.932	---
5.12	.436	.0247	-.0373	-.002	1.920	.021
5.12	.441	.0138	-.0290	.012	1.819	.113
5.12	.445	.0027	-.0226	.025	1.715	.188
5.11	.448	-.0061	-.0141	.037	1.635	.245
a6.14	.524	.0270	-.0261	---	---	---
6.14	.525	.0305	-.0297	-.004	1.957	---
6.14	.525	.0285	-.0279	.001	1.925	.018
6.14	.528	.0178	-.0210	.009	1.814	.113
6.14	.537	.0057	-.0139	.026	1.718	.186
6.14	.540	-.0034	-.0082	.038	1.639	.243
a7.16	.611	.0325	-.0229	---	---	---
7.16	.615	.0357	-.0229	-.004	1.960	---
7.16	.621	.0321	-.0159	.005	1.866	.078
7.17	.627	.0174	-.0088	.019	1.765	.161
7.17	.630	.0123	-.0053	.026	1.780	.190
7.17	.637	.0023	.0001	.038	1.635	.246
a8.18	.698	.0437	-.0147	---	---	---
8.19	.702	.0441	-.0140	-.005	1.948	---
8.19	.722	.0358	-.0062	.007	1.861	.081
8.19	.719	.0270	.0014	.019	1.771	.155
8.19	.723	.0219	.0051	.026	1.718	.193
8.19	.726	.0130	.0095	.037	1.651	.245
a9.19	.750	.0397	-.0105	---	---	---
9.20	.779	.0575	-.0005	-.005	1.956	---
9.21	.787	.0509	-.0039	.005	1.876	.065
9.21	.797	.0404	.0086	.019	1.775	.150
9.21	.800	.0354	.0152	.026	1.724	.194
9.21	.805	.0261	.0198	.037	1.650	.246
a10.21	.806	.0803	-.0007	---	---	---
10.21	.828	.0784	.0191	-.005	1.960	---
10.22	.843	.0715	.0251	.006	1.877	.079
10.22	.858	.0683	.0296	.019	1.781	.159
10.22	.861	.0558	.0385	.028	1.721	.208
10.23	.864	.0506	.0358	.037	1.664	.245

M, 0.80

α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
a2.04	0.167	0.0207	-0.0478	---	---	---
2.04	.168	.0246	-.0683	-0.006	1.958	---
2.04	.163	.0195	-.0645	.001	1.902	0.046
2.04	.168	.0121	-.0610	.010	1.827	.090
2.04	.161	-.0017	-.0531	.025	1.705	.169
2.04	.161	-.0078	-.0508	.031	1.671	.214
a3.07	.269	.0211	-.0474	---	---	---
3.07	.265	.0252	-.0614	-.006	1.959	---
3.07	.266	.0202	-.0569	0	1.909	.045
3.07	.267	.0108	-.0528	.012	1.810	.119
3.07	.268	.0017	-.0466	.023	1.728	.180
3.07	.268	-.0033	-.0449	.030	1.687	.209
a4.10	.369	.0234	-.0483	---	---	---
4.10	.369	.0278	-.0388	-.005	1.957	---
4.10	.369	.0229	-.0461	0	1.913	.042
4.10	.371	.0139	-.0409	.012	1.819	.114
4.10	.374	.0035	-.0367	.024	1.785	.187
4.10	.378	-.0005	-.0349	.029	1.691	.206
a5.13	.473	.0276	-.0390	---	---	---
5.11	.474	.0316	-.0466	-.005	1.958	---
5.13	.474	.0271	-.0483	0	1.906	.040
5.13	.479	.0184	-.0364	.012	1.822	.116
5.13	.483	.0079	-.0300	.024	1.787	.197
5.13	.485	.0036	-.0285	.030	1.684	.209
a6.16	.571	.0566	-.0350	---	---	---
6.16	.581	.0391	-.0412	-.005	1.964	---
6.16	.582	.0358	-.0373	-.001	1.927	.033
6.16	.586	.0258	-.0311	.013	1.817	.122
6.16	.590	.0165	-.0250	.024	1.733	.185
6.16	.592	.0131	-.0233	.030	1.694	.235
a7.18	.648	.0500	-.0299	---	---	---
7.18	.674	.0515	-.0325	-.005	1.971	---
7.18	.676	.0473	-.0285	0	1.929	.040
7.19	.676	.0395	-.0236	.012	1.839	.127
7.19	.679	.0296	-.0181	.024	1.738	.187
7.19	.681	.0270	-.0170	.030	1.702	.209
a8.19	.700	.0679	-.0160	---	---	---
8.20	.734	.0691	-.0106	-.005	1.977	---
8.20	.737	.0658	-.0069	0	1.932	.039
8.20	.737	.0589	-.0086	.018	1.834	.128
8.20	.748	.0488	.0030	.024	1.743	.185
8.20	.749	.0451	.0068	.030	1.701	.211
a9.19	.743	.0882	-.0084	---	---	---
9.21	.788	.0900	.0064	-.005	1.979	---
9.21	.793	.0867	.0123	-.001	1.939	.050
9.21	.798	.0766	.0184	.011	1.841	.119
9.21	.808	.0704	.0245	.023	1.738	.184
9.22	.811	.0655	.0265	.030	1.706	.217
a10.19	.782	.1091	-.0045	---	---	---
10.21	.823	.1121	.0238	-.006	1.989	---
10.21	.839	.1086	.0299	-.001	1.946	.039
10.22	.841	.0986	.0298	.011	1.840	.125
10.22	.846	.0935	.0302	.022	1.762	.185
10.22	.849	.0908	.0313	.028	1.716	.211

aProps off.

TABLE XI.- LONGITUDINAL CHARACTERISTICS OF A FOUR-ENGINE TRACTOR AIRPLANE CONFIGURATION HAVING A WING WITH 40° OF SWEEPBACK AND AN ASPECT RATIO OF 10; TAIL HEIGHT = 0.10 b/2, $i_t = -4°$, $\beta = 51°$, R = 1,000,000

M = 0.70, 0.80, 0.90

M, 0.70

α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
a2.03	0.128	0.0898	0.0994	- - -	- - -	- - -
2.02	.113	.0847	.0789	-0.008	2.777	- - -
2.02	.109	.0155	.0788	.008	2.575	0.207
2.02	.106	.0059	.0673	.021	2.370	.363
2.02	.103	-.0077	.0996	.037	2.173	.559
2.02	.102	-.0837	.1092	.057	1.959	.723
a3.06	.226	.0831	.0697	- - -	- - -	- - -
3.05	.217	.0851	.0495	-.002	2.781	- - -
3.05	.214	.0157	.0724	.008	2.569	.192
3.05	.213	.0054	.0640	.021	2.377	.381
3.05	.203	-.0074	.0779	.036	2.175	.529
3.05	.202	-.0834	.0877	.057	1.968	.659
a4.08	.326	.0844	.0487	- - -	- - -	- - -
4.08	.322	.0866	.0277	-.002	2.778	- - -
4.08	.318	.0181	.0349	.008	2.576	.186
4.08	.318	.0068	.0429	.021	2.376	.380
4.08	.320	-.0061	.0593	.037	2.180	.543
4.08	.321	-.0851	.0714	.056	1.964	.663
a5.11	.424	.0869	.0216	- - -	- - -	- - -
5.11	.420	.0869	.0145	-.002	2.772	- - -
5.11	.418	.0202	.0280	.007	2.575	.184
5.11	.421	.0069	.0343	.021	2.377	.380
5.11	.424	-.0036	.0501	.038	2.177	.545
5.11	.427	-.0169	.0606	.055	1.959	.665
a6.14	.523	.0509	.0013	- - -	- - -	- - -
6.14	.519	.0327	-.0019	-.002	2.784	- - -
6.14	.519	.0465	.0076	.008	2.572	.186
6.14	.522	.0137	.0210	.022	2.383	.385
6.14	.526	.0014	.0347	.039	2.181	.548
6.14	.533	-.0126	.0448	.057	1.966	.677
a7.16	.616	.0371	-.0187	- - -	- - -	- - -
7.16	.614	.0356	-.0184	-.001	2.785	- - -
7.16	.616	.0304	-.0086	.009	2.575	.197
7.16	.621	.0805	.0031	.023	2.384	.387
7.17	.627	.0089	.0165	.038	2.184	.548
7.17	.635	-.0033	.0258	.056	1.992	.669
a8.19	.701	.0490	-.0318	- - -	- - -	- - -
8.19	.706	.0461	-.0285	-.001	2.789	- - -
8.19	.711	.0404	-.0189	.008	2.589	.200
8.19	.716	.0322	-.0093	.023	2.386	.392
8.19	.723	.0198	.0022	.036	2.185	.524
8.20	.730	.0067	.0114	.057	1.980	.660
a9.20	.759	.0665	-.0378	- - -	- - -	- - -
9.20	.781	.0642	-.0301	0.	2.804	- - -
9.21	.787	.0549	-.0251	.010	2.566	.207
9.21	.795	.0478	-.0159	.023	2.391	.383
9.21	.806	.0351	-.0083	.040	2.175	.522
9.22	.815	.0257	-.0008	.058	1.991	.658
a10.21	.810	.0918	-.0298	- - -	- - -	- - -
10.22	.846	.0889	-.0283	-.001	2.816	- - -
10.22	.847	.0796	-.0195	.009	2.580	.240
10.22	.860	.0689	-.0138	.022	2.379	.416
10.23	.870	.0586	-.0064	.040	2.161	.575
10.23	.882	.0496	-.0008	.056	1.999	.666

M, 0.80

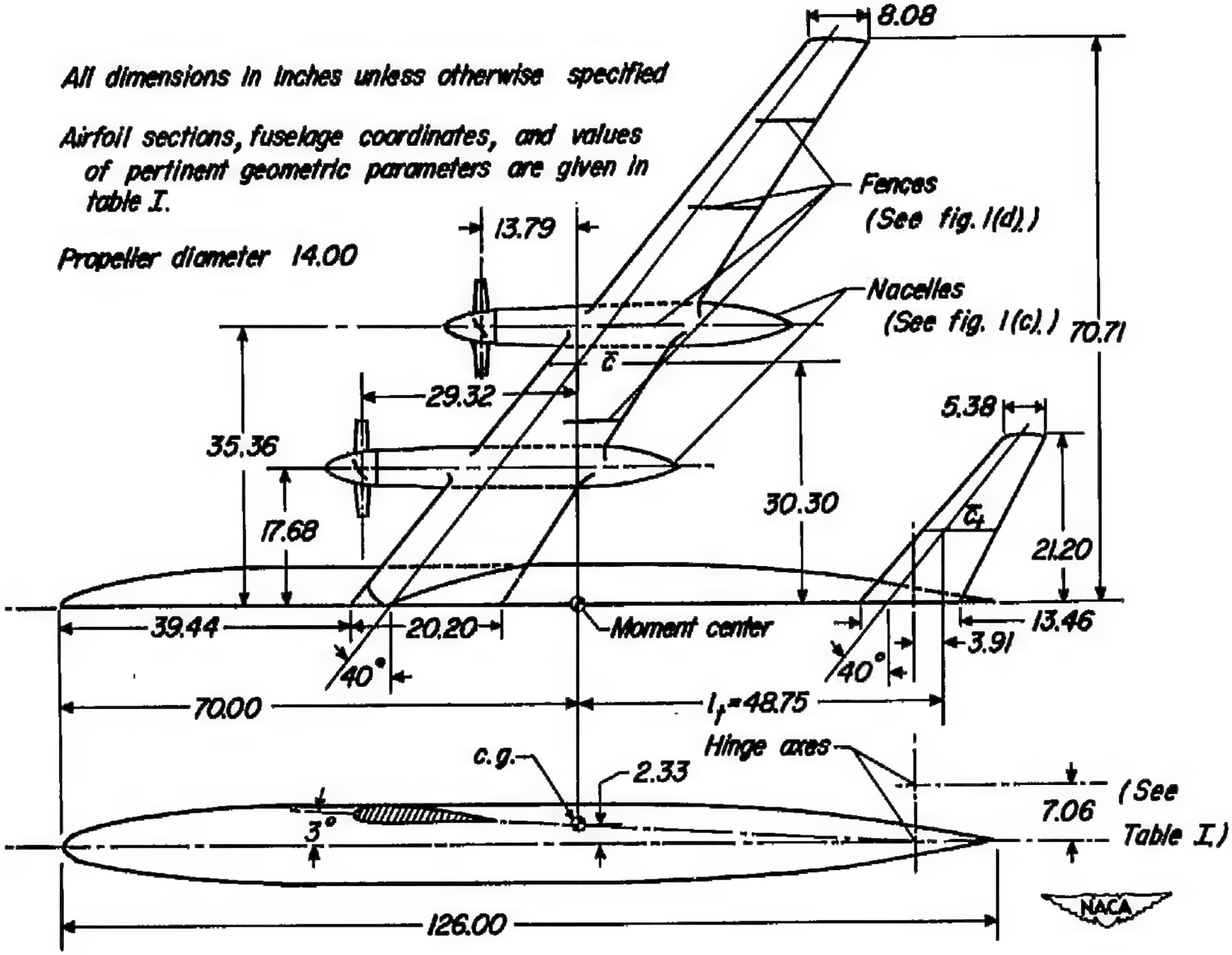
α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
a2.03	0.129	0.0252	0.0995	- - -	- - -	- - -
2.03	.122	.0262	.0690	-0.004	2.743	- - -
2.03	.118	.0193	.0783	.006	2.574	0.187
2.03	.116	.0098	.0885	.018	2.354	.338
2.03	.115	-.0015	.1002	.032	2.163	.490
2.09	.113	-.0138	.1075	.047	1.974	.592
a3.06	.244	.0259	.0640	- - -	- - -	- - -
3.06	.238	.0282	.0496	-.004	2.745	- - -
3.06	.234	.0197	.0541	.006	2.579	.183
3.06	.234	.0095	.0642	.018	2.368	.359
3.06	.235	-.0013	.0757	.032	2.165	.491
3.06	.235	-.0127	.0833	.046	1.958	.595
a4.10	.355	.0261	.0427	- - -	- - -	- - -
4.09	.351	.0303	.0260	-.004	2.744	- - -
4.09	.349	.0218	.0370	.006	2.565	.191
4.09	.350	.0123	.0473	.018	2.367	.358
4.09	.355	.0014	.0564	.032	2.172	.488
4.09	.354	-.0105	.0672	.046	1.995	.595
a5.13	.466	.0331	.0218	- - -	- - -	- - -
5.12	.463	.0350	.0110	-.004	2.752	- - -
5.12	.464	.0270	.0246	.007	2.568	.179
5.13	.465	.0167	.0345	.019	2.371	.356
5.13	.468	.0058	.0468	.033	2.173	.497
5.13	.471	-.0046	.0558	.046	2.002	.592
a6.15	.563	.0440	.0008	- - -	- - -	- - -
6.16	.567	.0431	-.0047	-.004	2.756	- - -
6.16	.570	.0358	.0091	.007	2.571	.186
6.16	.573	.0265	.0218	.019	2.377	.350
6.16	.577	.0165	.0337	.033	2.181	.494
6.16	.580	.0061	.0406	.047	2.011	.590
a7.14	.655	.0593	-.0084	- - -	- - -	- - -
7.18	.662	.0575	-.0093	-.004	2.767	- - -
7.18	.665	.0492	-.0026	.007	2.579	.188
7.18	.668	.0407	.0107	.019	2.379	.359
7.18	.669	.0309	.0209	.033	2.183	.505
7.18	.671	.0211	.0262	.047	2.011	.595
a8.18	.688	.0779	-.0009	- - -	- - -	- - -
8.19	.722	.0756	-.0036	-.005	2.782	- - -
8.20	.726	.0678	.0064	.007	2.583	.198
8.20	.735	.0559	.0158	.018	2.389	.360
8.20	.739	.0496	.0242	.033	2.190	.505
8.20	.743	.0406	.0260	.046	2.085	.597
a9.19	.729	.0986	-.0081	- - -	- - -	- - -
9.20	.772	.0963	.0052	-.005	2.786	- - -
9.21	.787	.0882	.0094	.005	2.600	.189
9.21	.799	.0796	.0161	.018	2.390	.365
9.21	.802	.0704	.0183	.033	2.188	.518
9.21	.804	.0629	.0158	.046	2.027	.609
a10.19	.778	.1211	-.0072	- - -	- - -	- - -
10.21	.825	.1191	.0049	-.006	2.799	- - -
10.21	.825	.1123	.0047	.005	2.599	.205
10.22	.848	.1057	.0161	.018	2.397	.378
10.22	.855	.0927	.0223	.032	2.200	.518
10.22	.860	.0879	.0174	.045	2.062	.601

M, 0.90

α	C_L	C_X	C_m	$T_{c_{av}}$	J_{av}	$C_{P_{av}}$
a2.03	0.143	0.0407	0.1135	- - -	- - -	- - -
2.04	.154	.0459	.0957	-0.005	2.719	- - -
2.04	.151	.0354	.0873	.009	2.521	0.171
2.04	.148	.0256	.0818	.016	2.270	.328
2.04	.146	.0141	.0935	.026	2.030	.425
2.04	.145	.0077	.0988	.035	1.854	.462
a3.06	.242	.0443	.0776	- - -	- - -	- - -
3.07	.260	.0498	.0084	-.005	2.732	- - -
3.07	.265	.0909	.0955	.005	2.533	.161
3.07	.267	.0881	.0677	.019	2.245	.347
3.07	.268	.0185	.0740	.027	2.071	.416
3.07	.272	.0182	.0610	.034	1.913	.459
a4.08	.330	.0555	.0508	- - -	- - -	- - -
4.09	.354	.0585	.0082	-.005	2.788	- - -
4.09	.351	.0581	.0819	.002	2.591	.188
4.10	.358	.0407	.0905	.013	2.347	.294
4.10	.362	.0312	.0576	.023	2.143	.402
4.10	.370	.0886	.0474	.033	1.957	.465
a5.10	.417	.0658	.0357	- - -	- - -	- - -
5.11	.434	.0698	.0078	-.005	2.743	- - -
5.12	.438	.0609	.0159	.004	2.562	.185
5.12	.445	.0585	.0254	.014	2.355	.310
5.12	.443	.0455	.0338	.024	2.143	.404
5.12	.448	.0502	.0890	.033	1.960	.457
a6.13	.493	.0799	.0825	- - -	- - -	- - -
6.13	.522	.0822	.0068	-.004	2.757	- - -
6.14	.517	.0743	.0179	.007	2.562	.174
6.14	.527	.0698	.0889	.014	2.370	.310
6.14	.532	.0586	.0806	.025	2.174	.413
6.14	.540	.0511	.0554	.033	1.974	.480
a7.14	.559	.0940	.0505	- - -	- - -	- - -
7.15	.558	.0984	.0055	-.004	2.766	- - -
7.15	.594	.0907	.0148	.006	2.554	.186
7.16	.596	.0858	.0194	.014	2.377	.321
7.16	.600	.0807	.0825	.023	2.194	.405
7.16	.613	.0748	.0877	.032	1.997	.474
a8.16	.627	.1138	.0666	- - -	- - -	- - -
8.17	.651	.1193	.0096	-.005	2.780	- - -
8.17	.667	.1130	.0118	.003	2.617	.155
8.17	.674	.1077	.0154	.013	2.415	.289
8.18	.680	.0967	.0195	.022	2.216	.481
8.18	.683	.0936	.0184	.032	2.008	.477
a9.17	.689	.1348	.0214	- - -	- - -	- - -
9.18	.716	.1401	.0086	-.005	2.795	- - -
9.18	.734	.1352	.0065	.002	2.606	.154
9.19	.742	.1300	.0090	.013	2.430	.305
9.19	.754	.1209	.0124	.022	2.233	.481
9.20	.755	.1156	.0152	.032	2.011	.494
a10.18	.749	.1518	.0080	- - -	- - -	- - -
10.19	.760	.1618	.0077	-.005	2.799	- - -
10.21	.811	.1599	-.0008	.003	2.623	.159
10.22	.817	.1596	.0019	.012	2.433	.314
10.21	.827	.1476	-.0006	.022	2.236	.429
10.18	.832	.1456	.0085	.032	2.056	.508

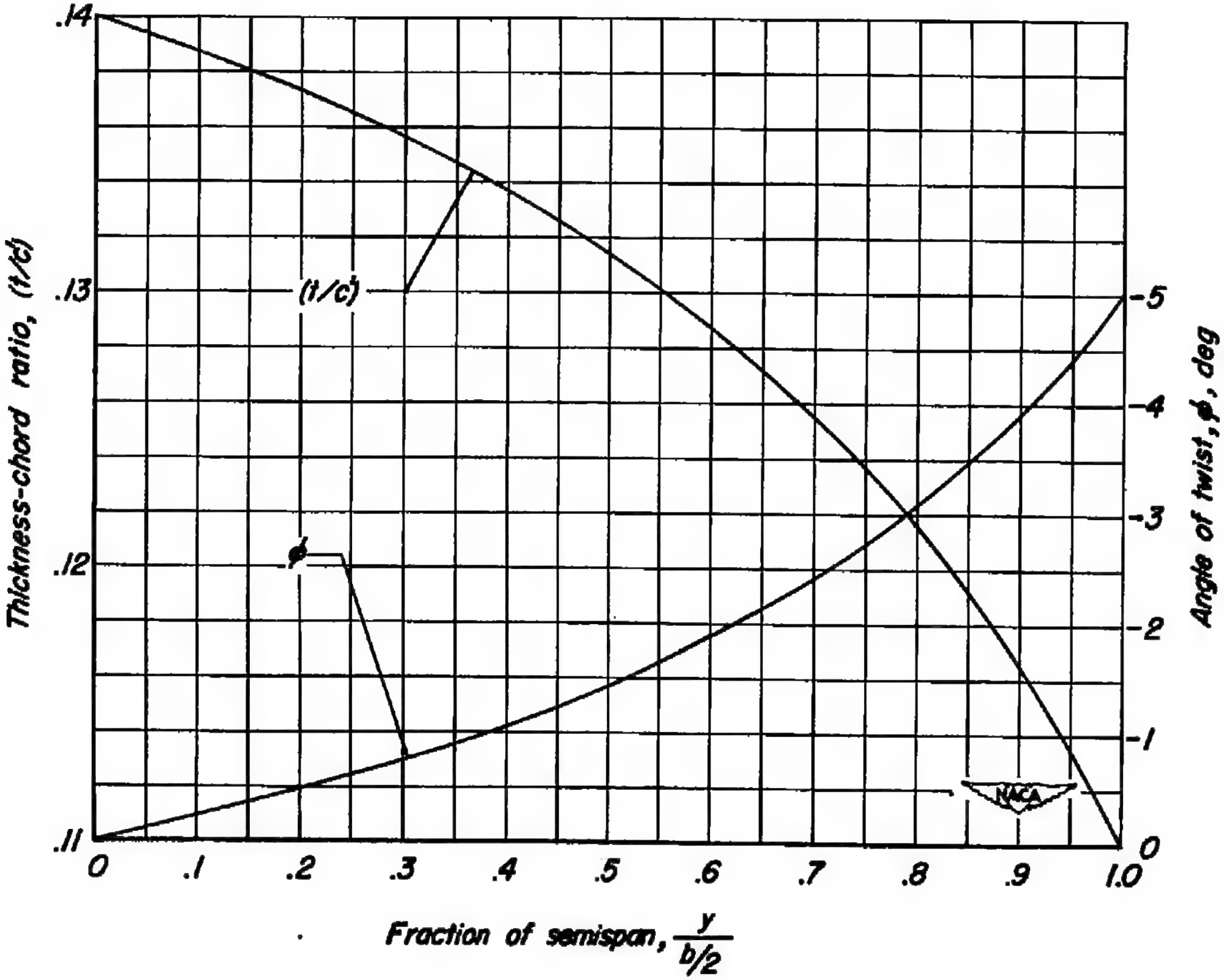
aProps off.

NACA



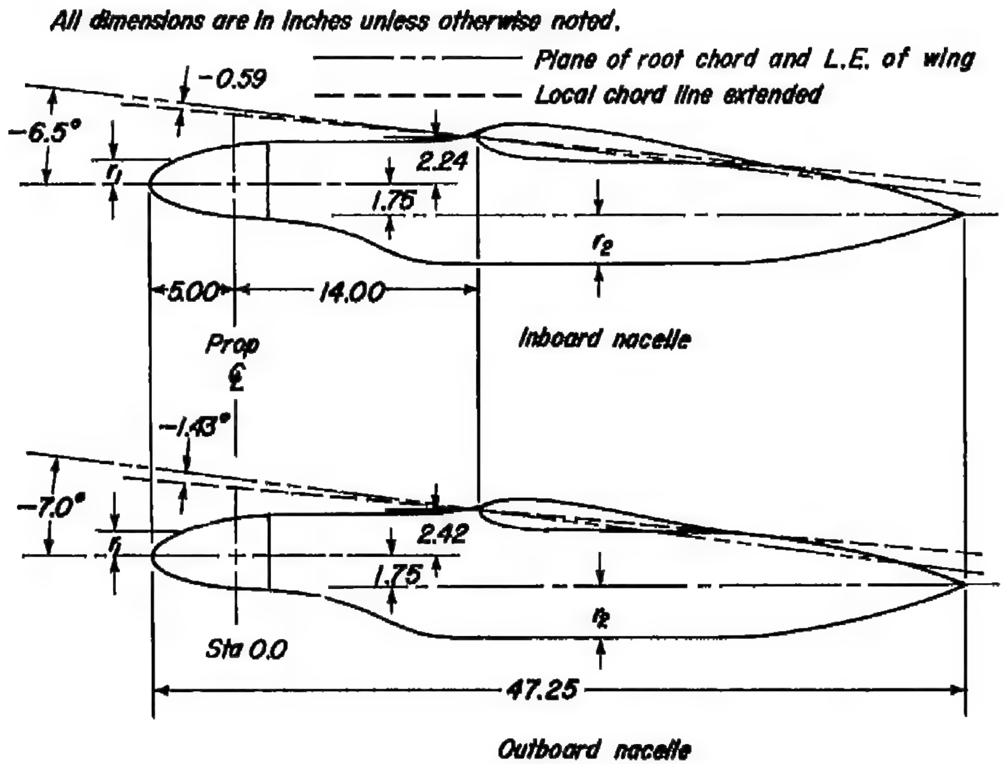
(a) Dimensions.

Figure 1.- Geometry of the model.



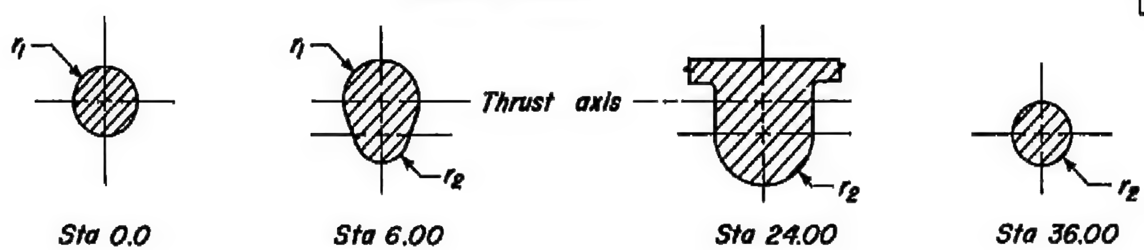
(b) Wing twist and thickness-chord ratio.

Figure 1.- Continued.



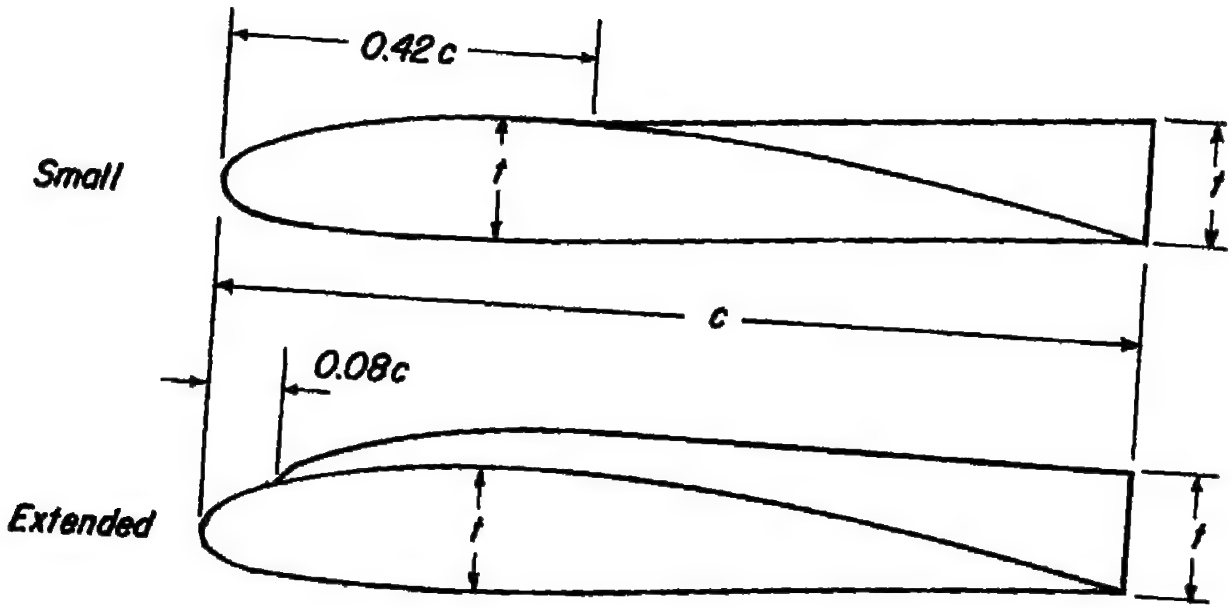
Nacelle coordinates

Sta	r_1	Sta	r_2
-5.00	0	2.00	0.350
-4.79	.385	3.00	.419
-4.58	.567	4.00	.616
-4.25	.788	5.00	.919
-3.95	.951	6.00	1.290
-3.25	1.242	7.00	1.685
-2.55	1.472	8.00	2.056
-1.80	1.670	9.00	2.359
-.80	1.871	10.00	2.556
0	1.985	11.00	2.625
2.00	2.100	30.50	2.625
12.00	2.100	32.50	2.450
		34.50	2.220
		36.50	1.825
		38.50	1.270
		40.50	.675
		41.50	.275
		42.25	0



(c) Nacelle details.

Figure 1.- Continued.



Type and location
Small at $\frac{y}{b/2} = 0.33$
Extended at $\frac{y}{b/2} = 0.50, 0.70, \text{and } 0.85$

(d) Fence details.

Figure 1.- Concluded.

Figure 2.- Photograph of the model in the wind tunnel.

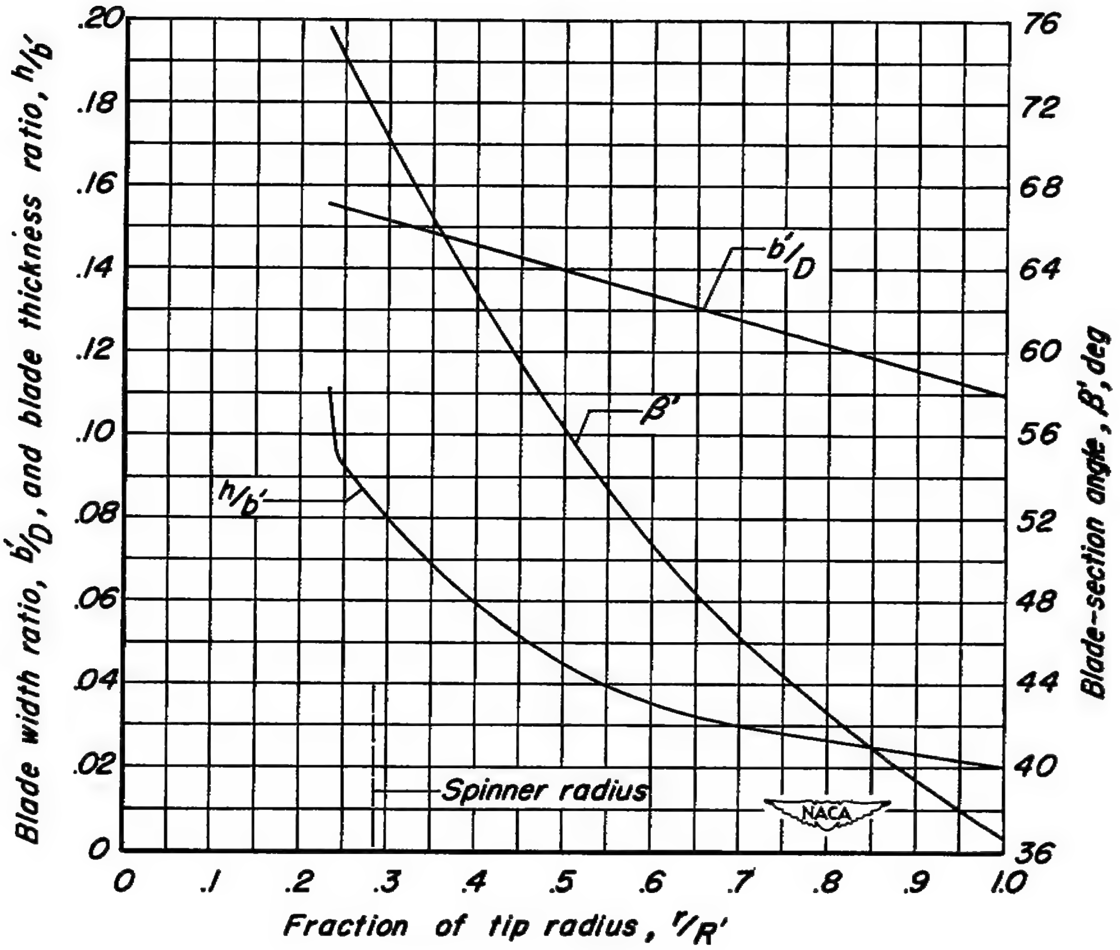
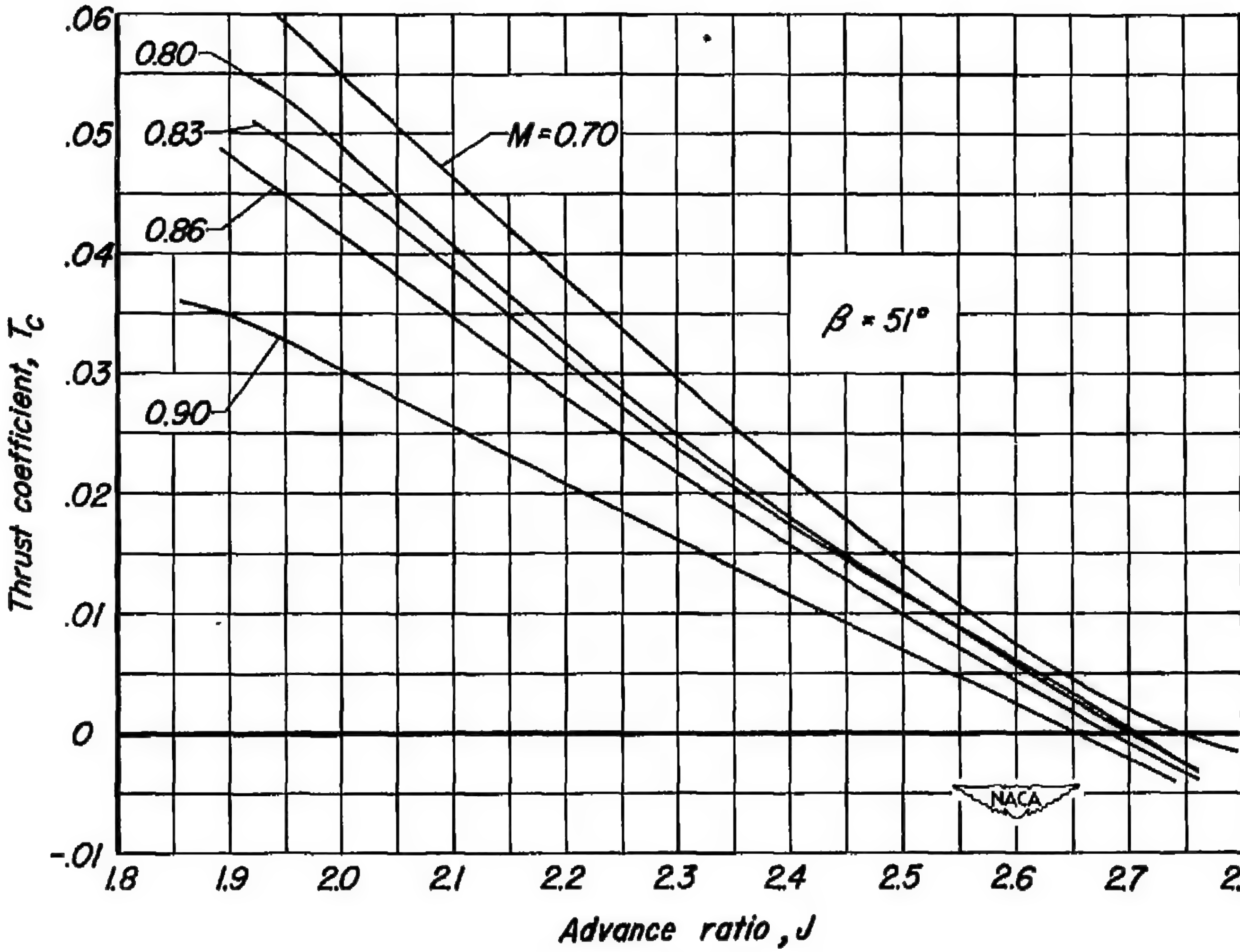
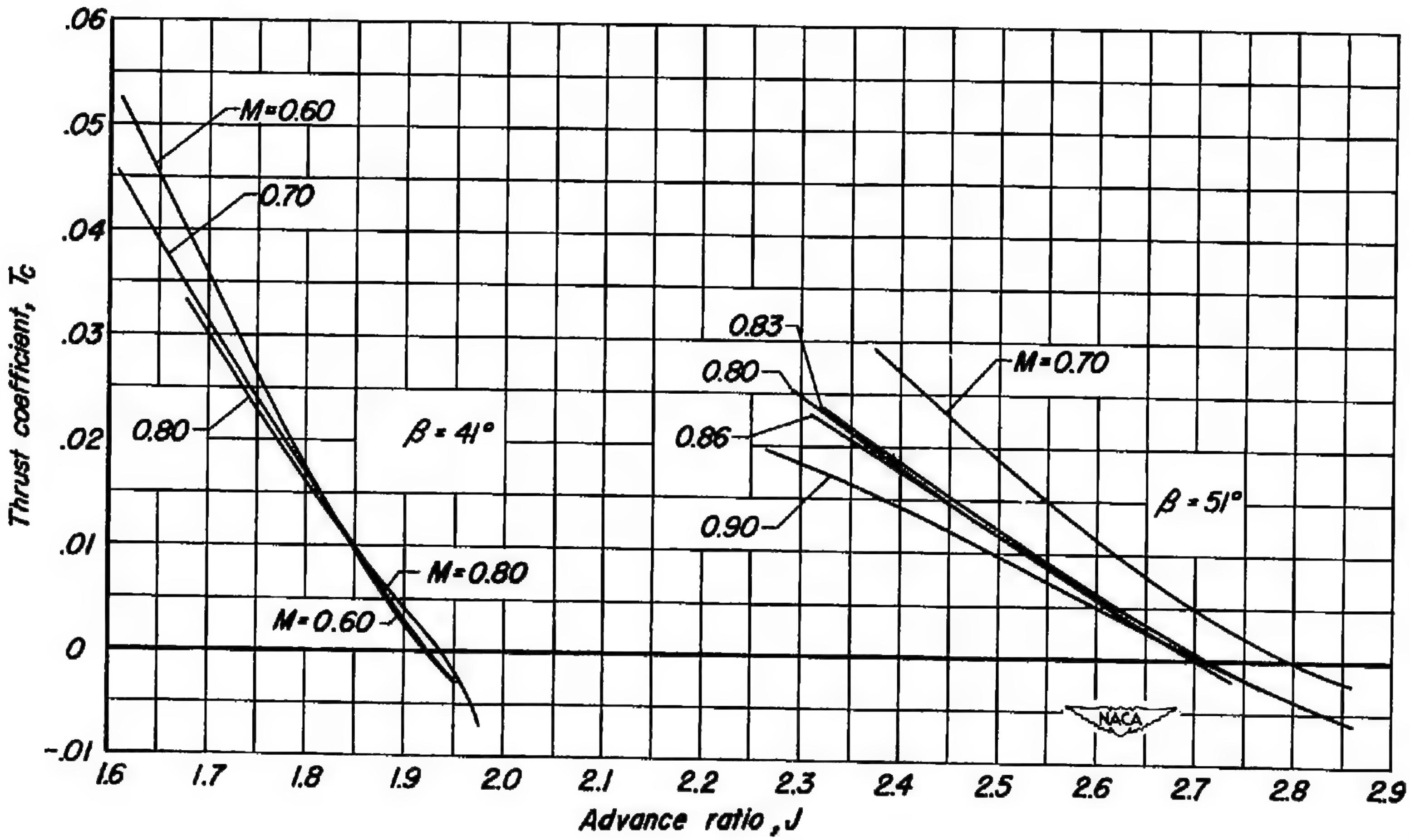


Figure 3.- Plan-form and blade-form curves for the NACA 1.167-(0)(03)-058 propeller.



(a) R = 1 × 10⁶

Figure 4.- The variation of thrust coefficient with advance ratio for the NACA 1.167-(0)(03)-058 propeller. A = 0°.



(b) $R = 2 \times 10^6$

Figure 4.- Concluded.

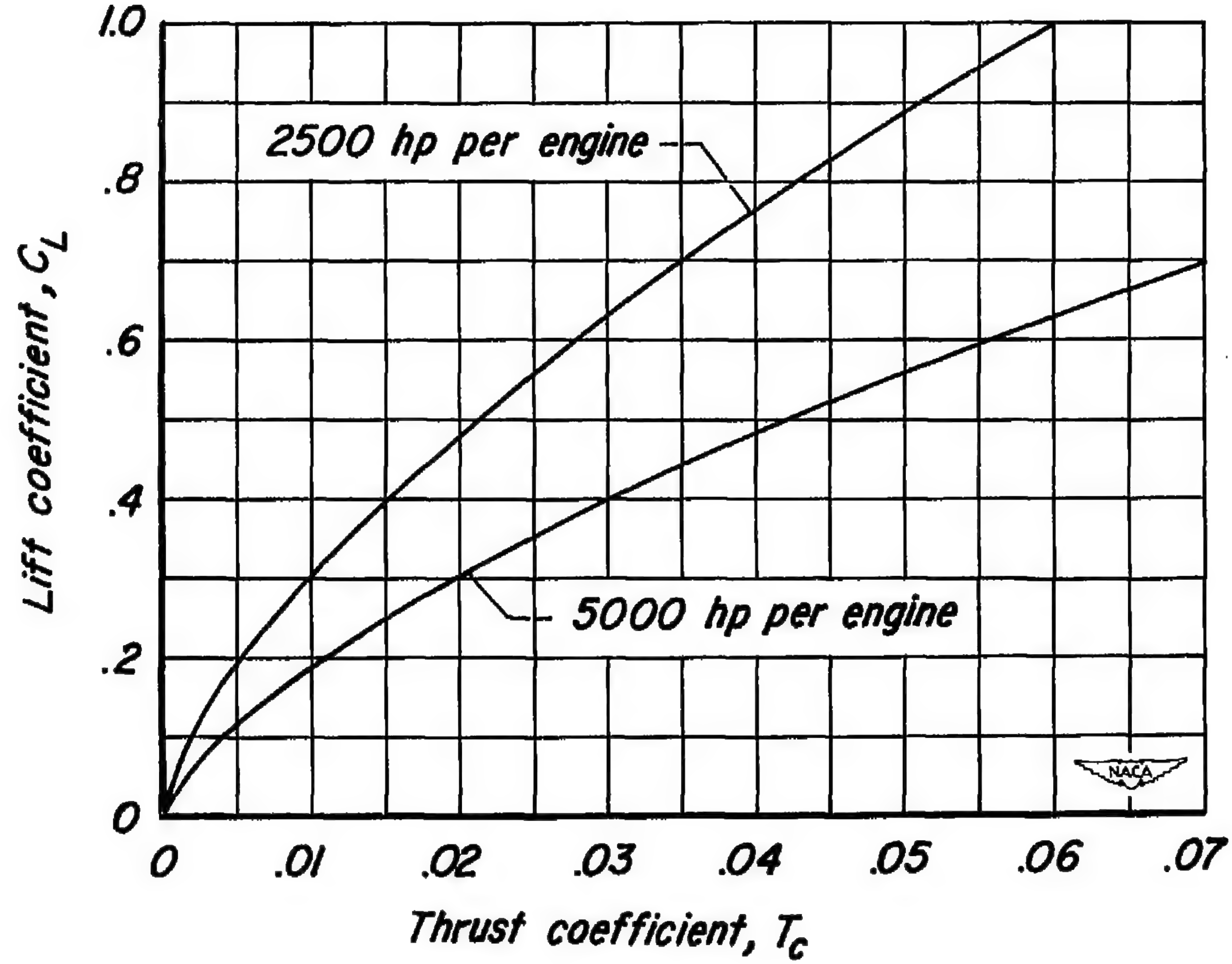
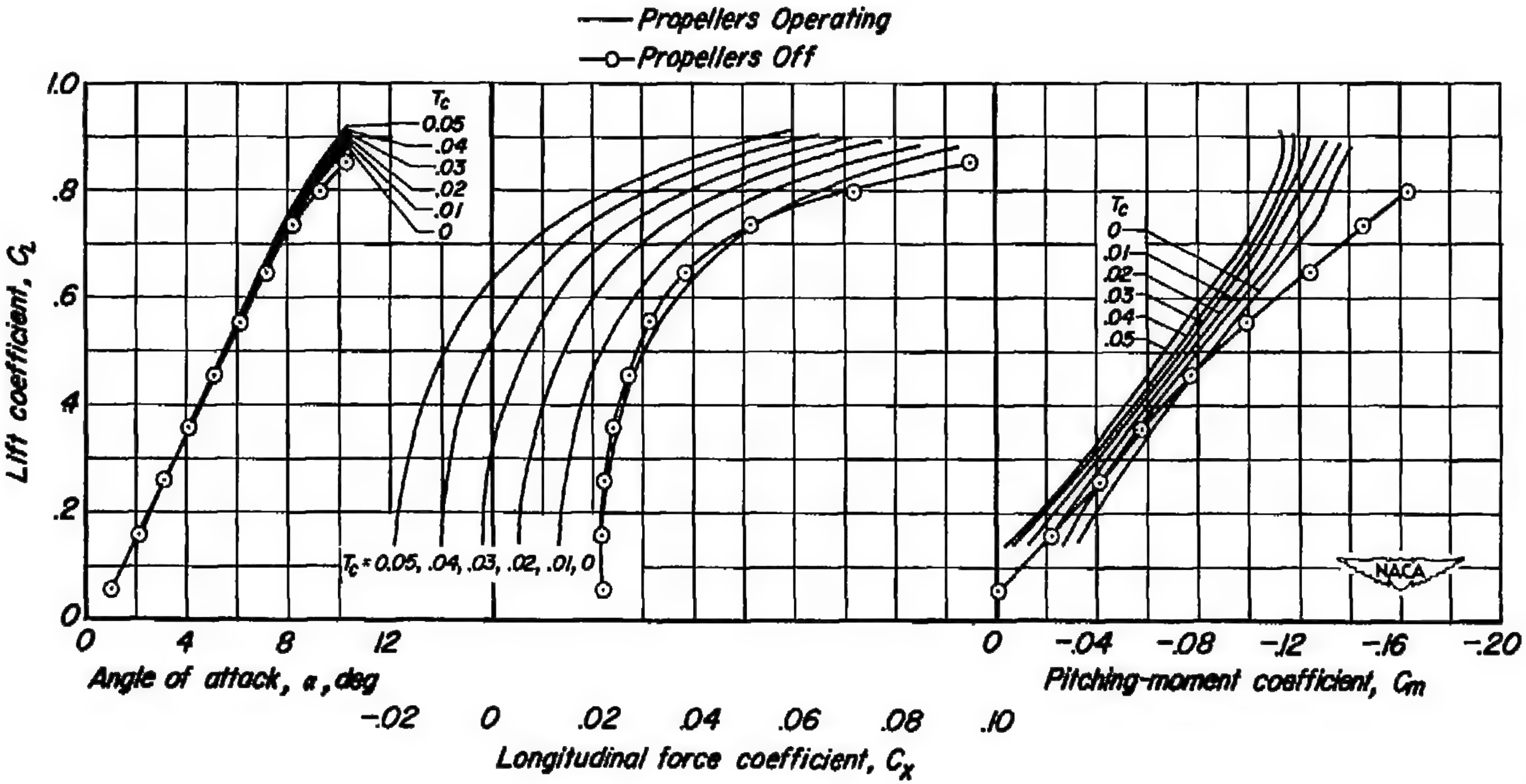
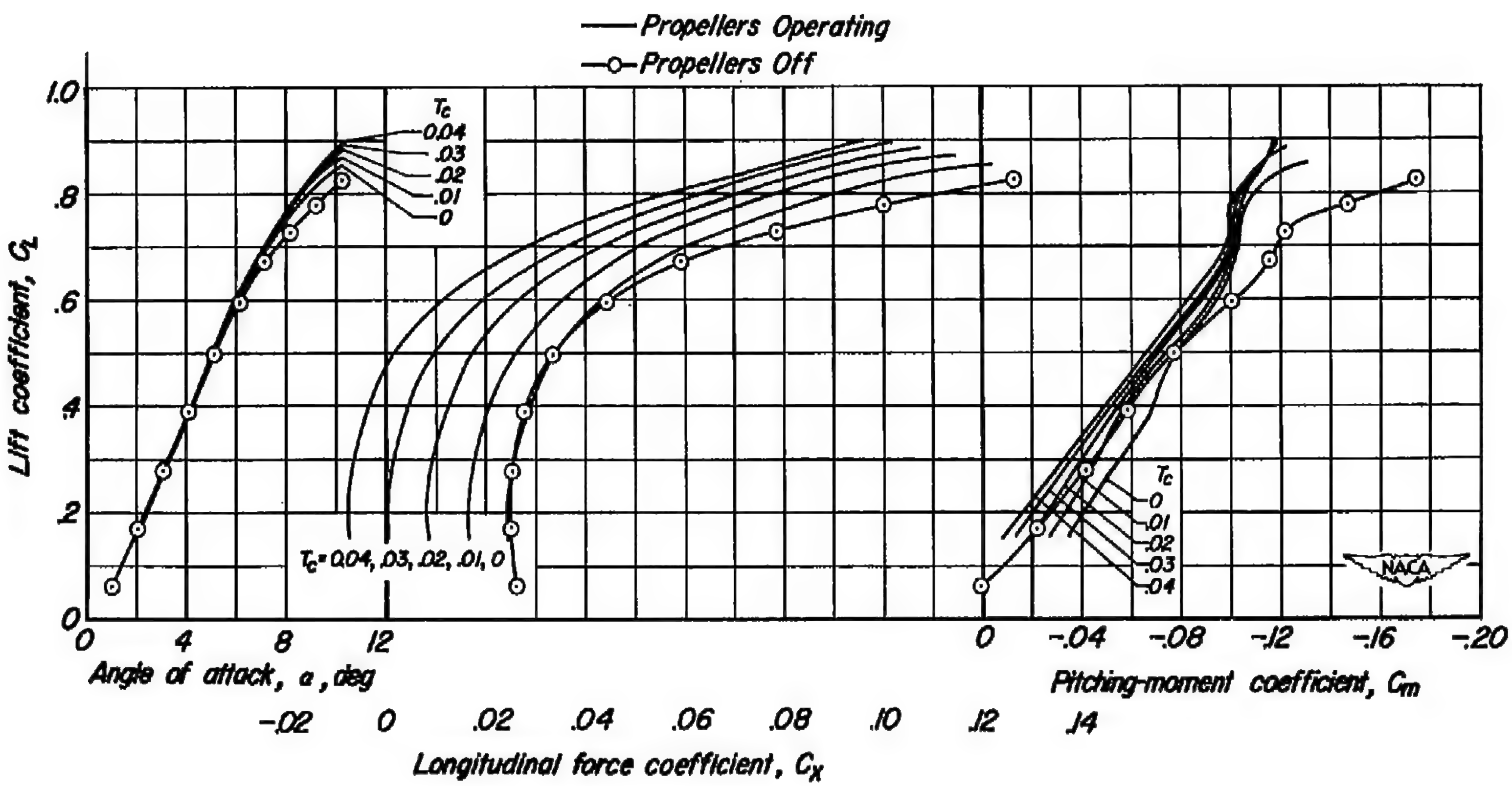


Figure 5.- Typical variations of lift coefficient with thrust coefficient for assumed full-scale power conditions. Altitude = 40,000 ft, $\eta_{assumed}$ = 0.65, W/S = 75 lb/sq ft.



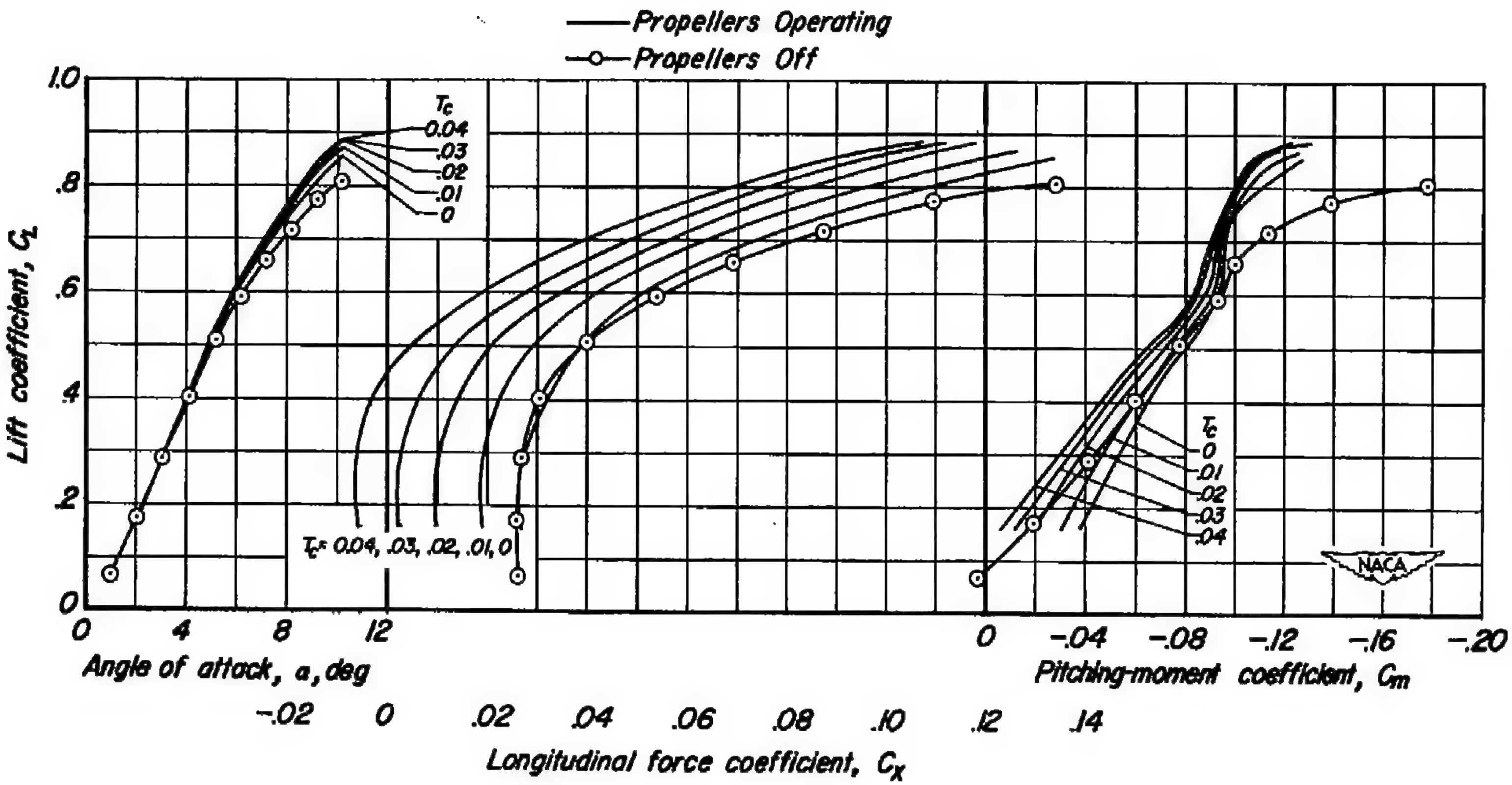
(a) M = 0.70

Figure 6.- The effect of operating propellers on the longitudinal characteristics of the model. Tail height = 0 b/2, i_t = -2°, β = 51°, R = 1 × 10^6.



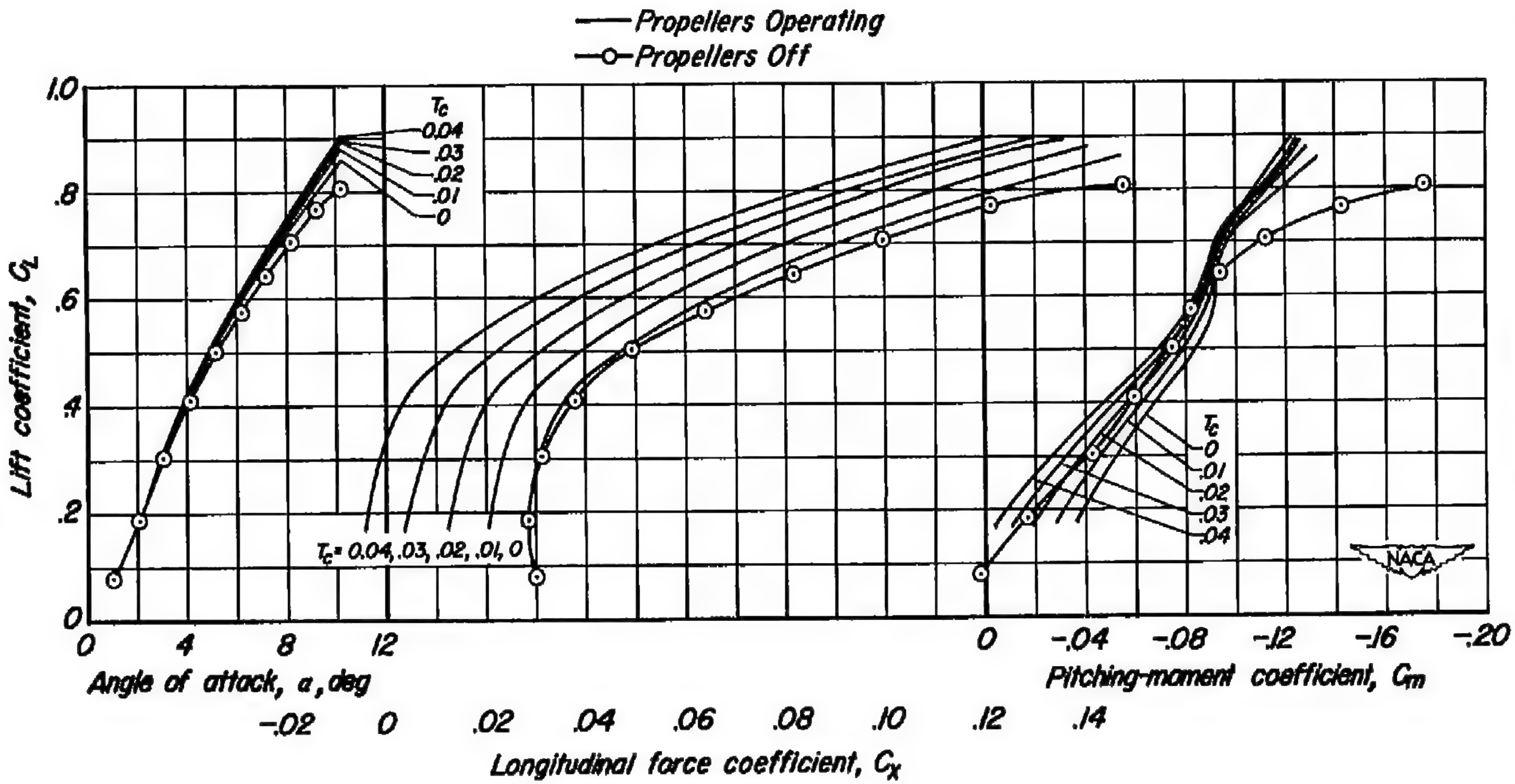
(b) M = 0.80

Figure 6.- Continued.



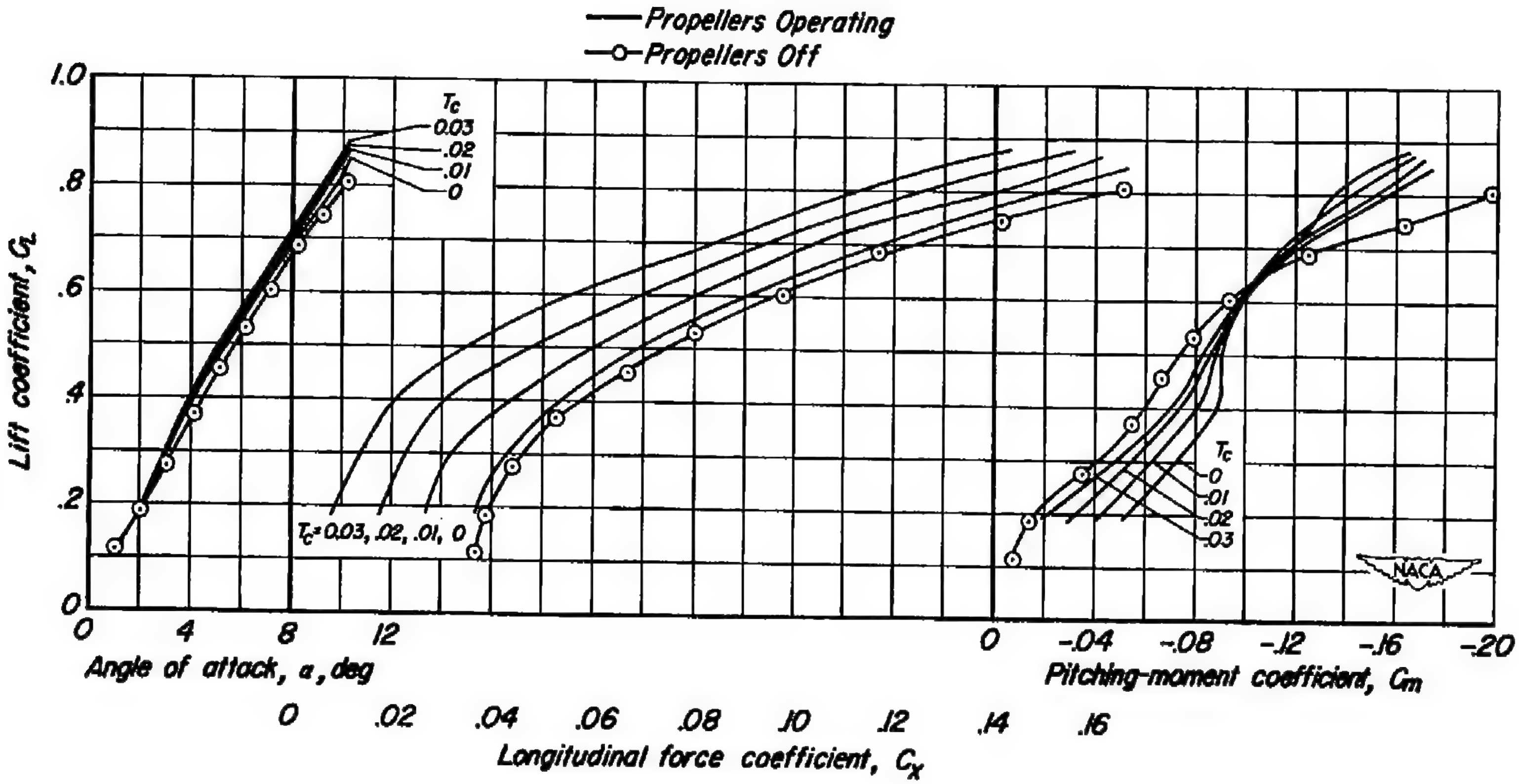
(c) M = 0.83

Figure 6.- Continued.



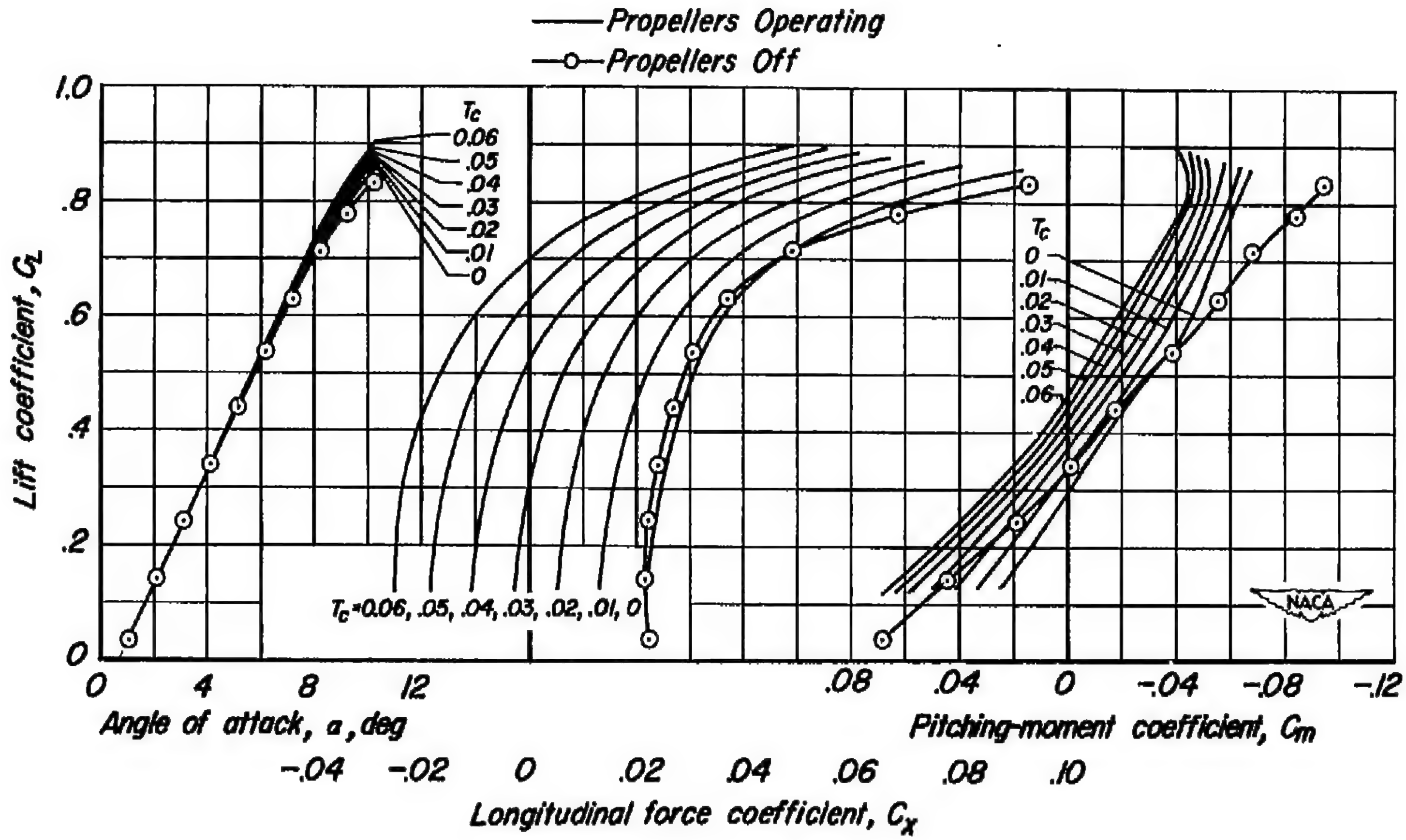
(d) M = 0.86

Figure 6.- Continued.



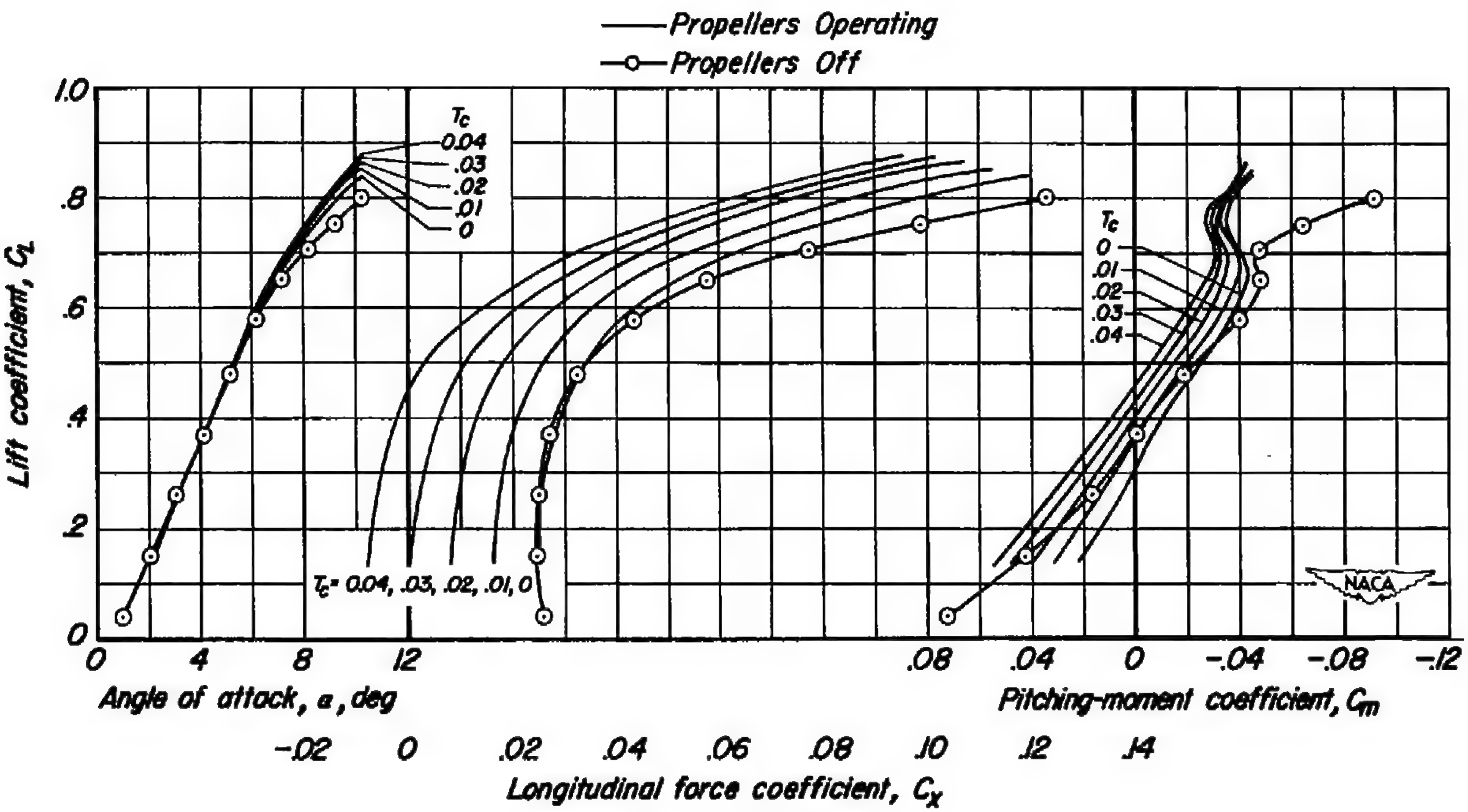
(e) M = 0.90

Figure 6.- Concluded.



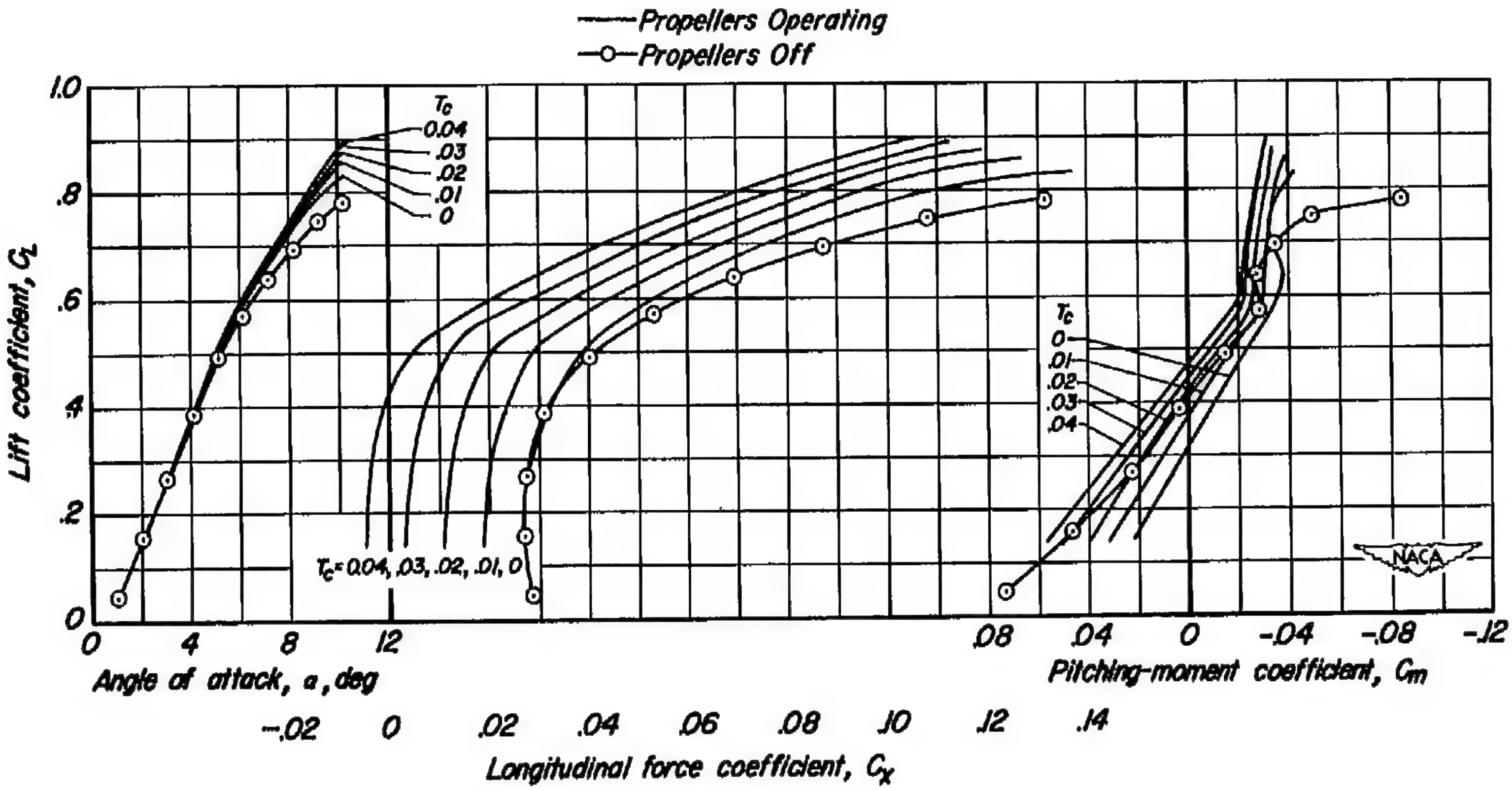
(a) M = 0.70

Figure 7.- The effect of operating propellers on the longitudinal characteristics of the model. Tail height = 0 b/2, i_t = -4°, β = 51°, R = 1 × 10⁶.



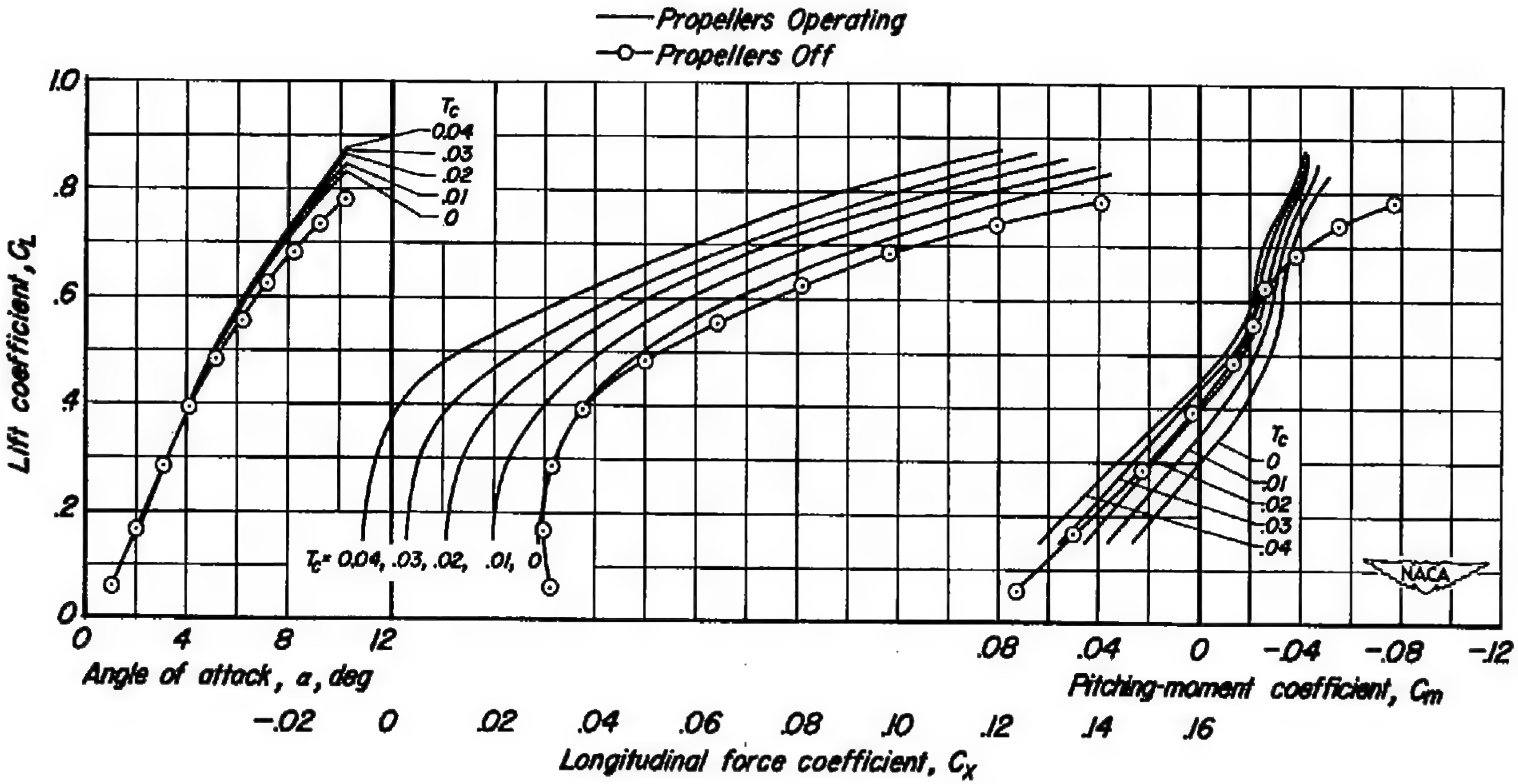
(b) M = 0.80

Figure 7.- Continued.



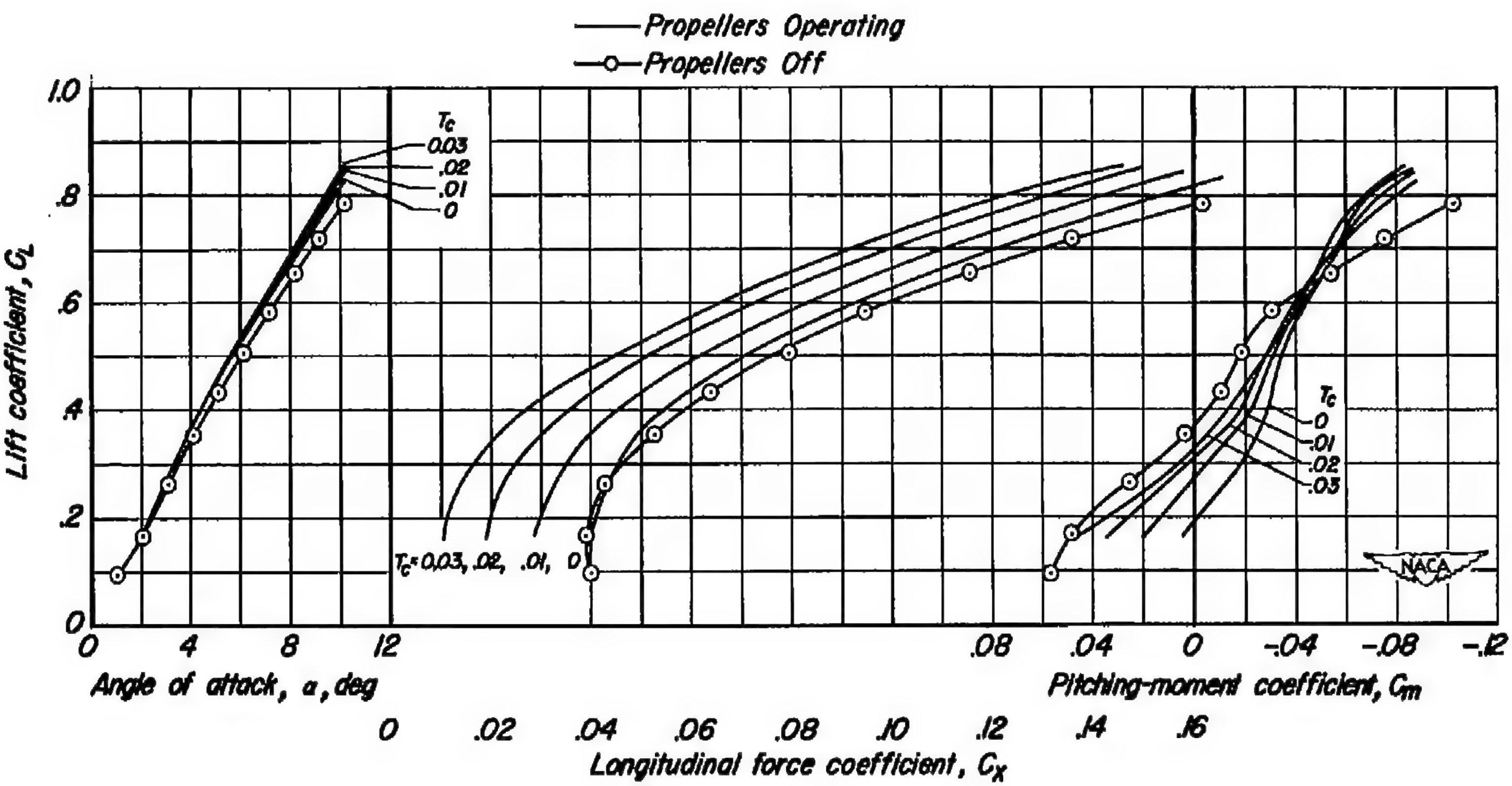
(c) M = 0.83

Figure 7.- Continued.



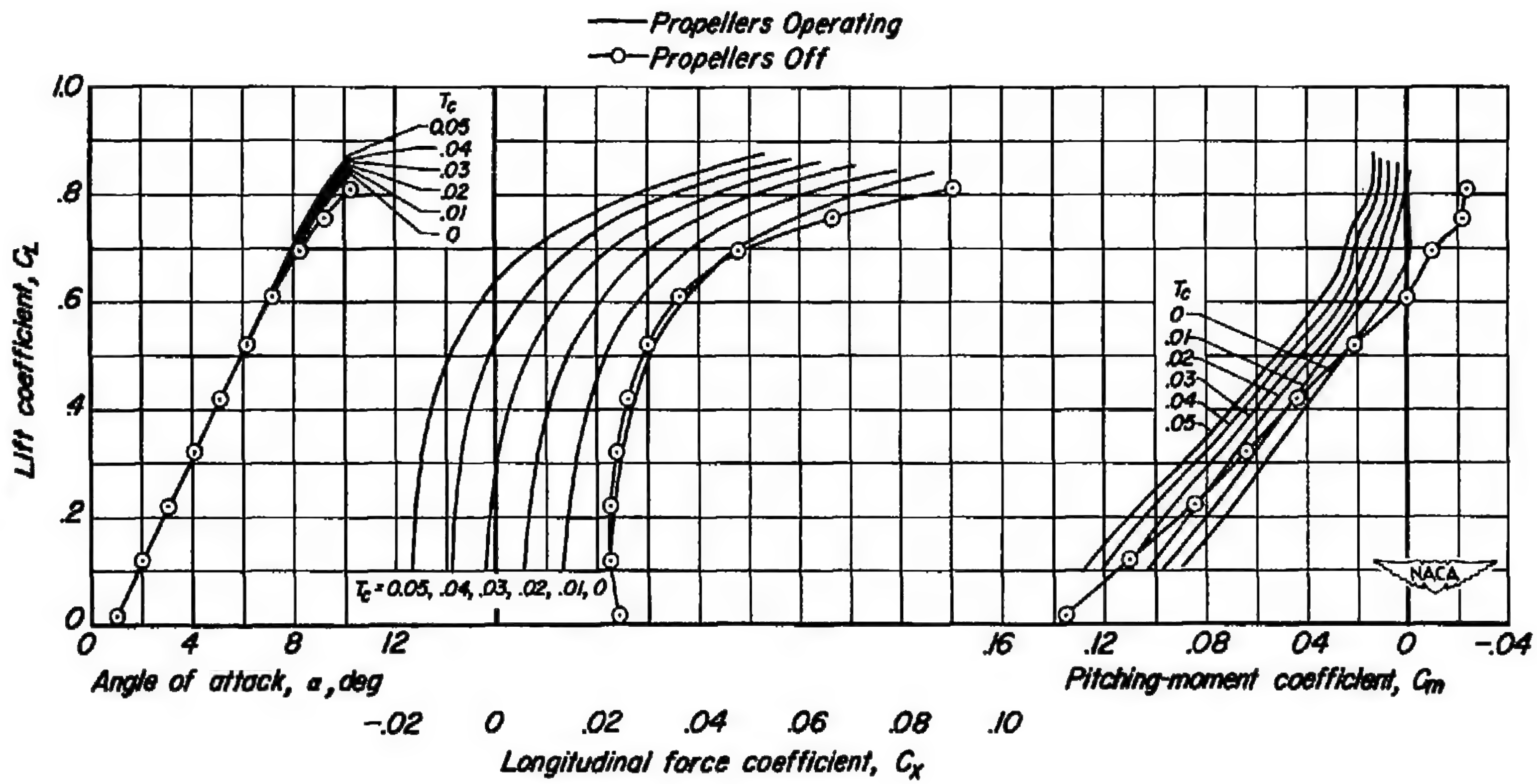
(d) M = 0.86

Figure 7.- Continued.



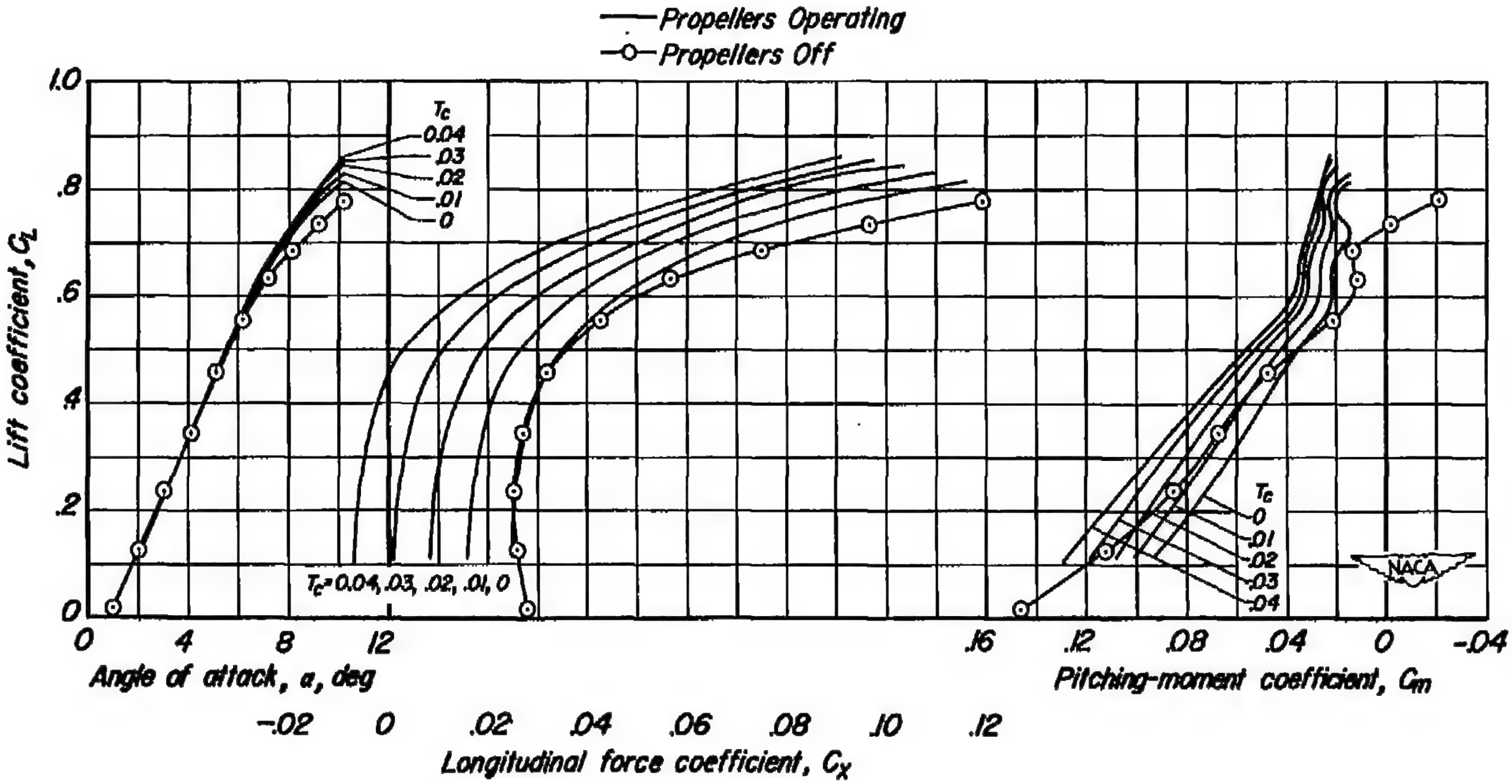
(e) M = 0.90

Figure 7.- Concluded.



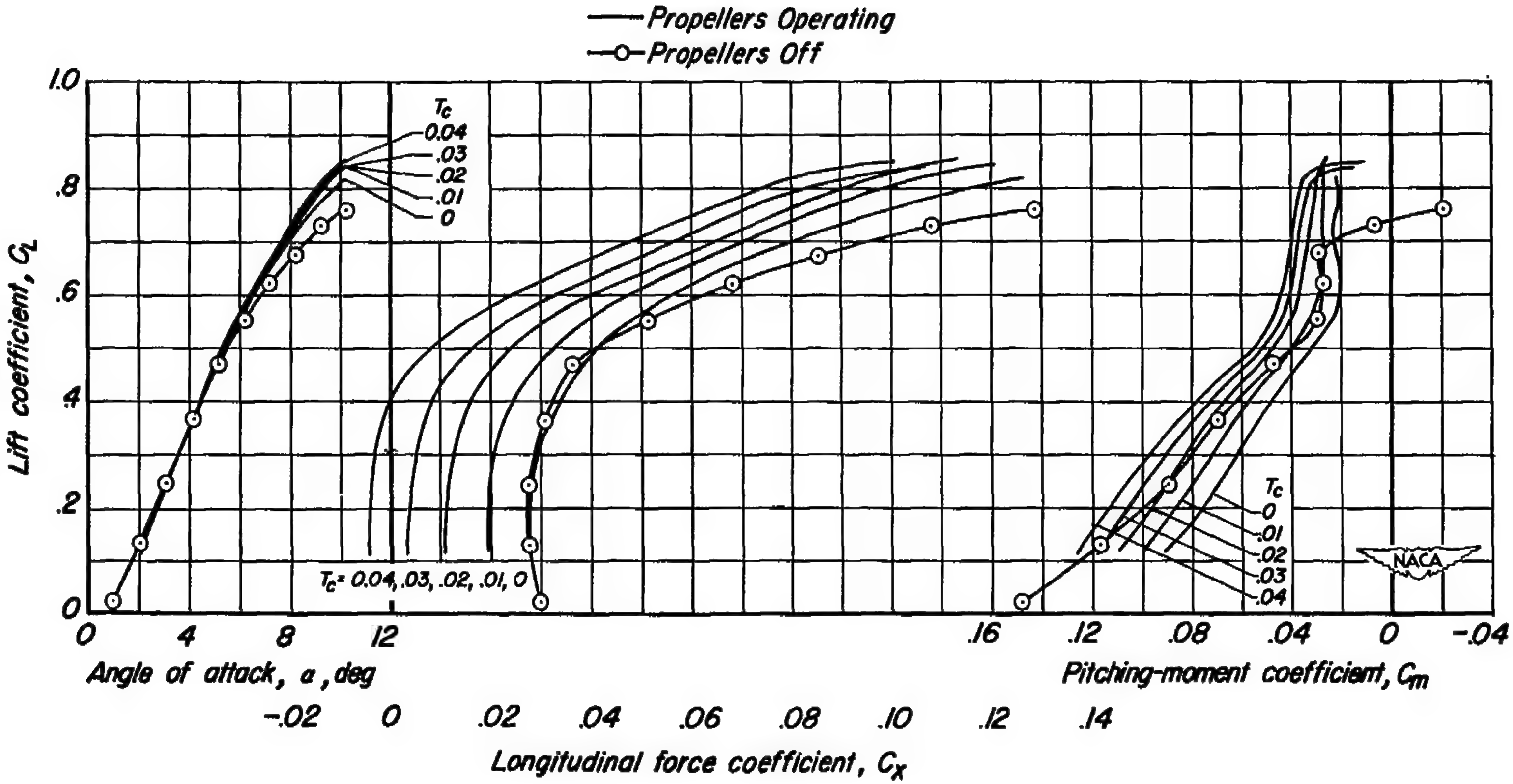
(a) M = 0.70

Figure 8.- The effect of operating propellers on the longitudinal characteristics of the model. Tail height = 0 b/2, i_t = -6°, $\beta = 51^\circ$, R = 1×10^6.



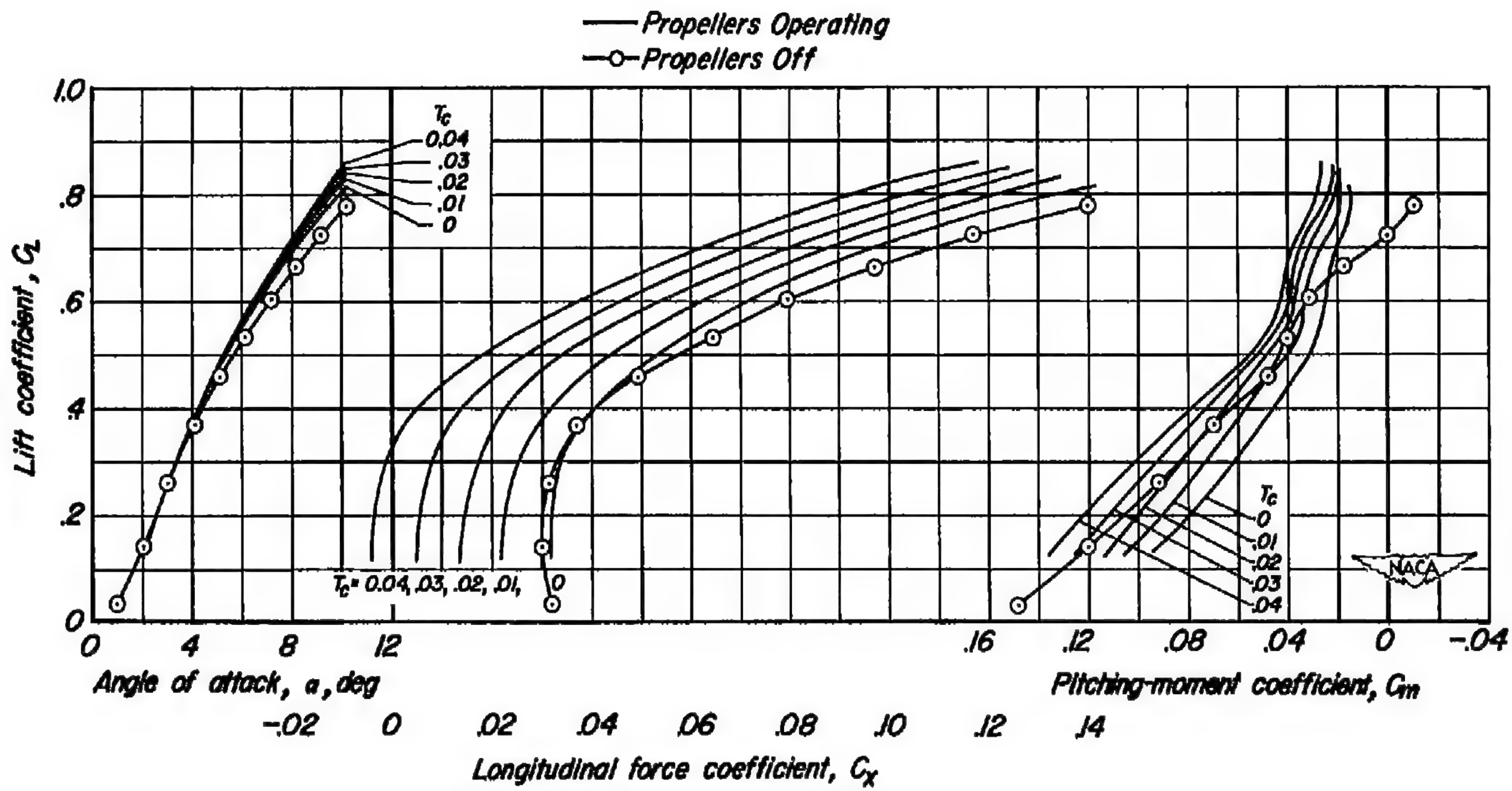
(b) M = 0.80

Figure 8.- Continued.



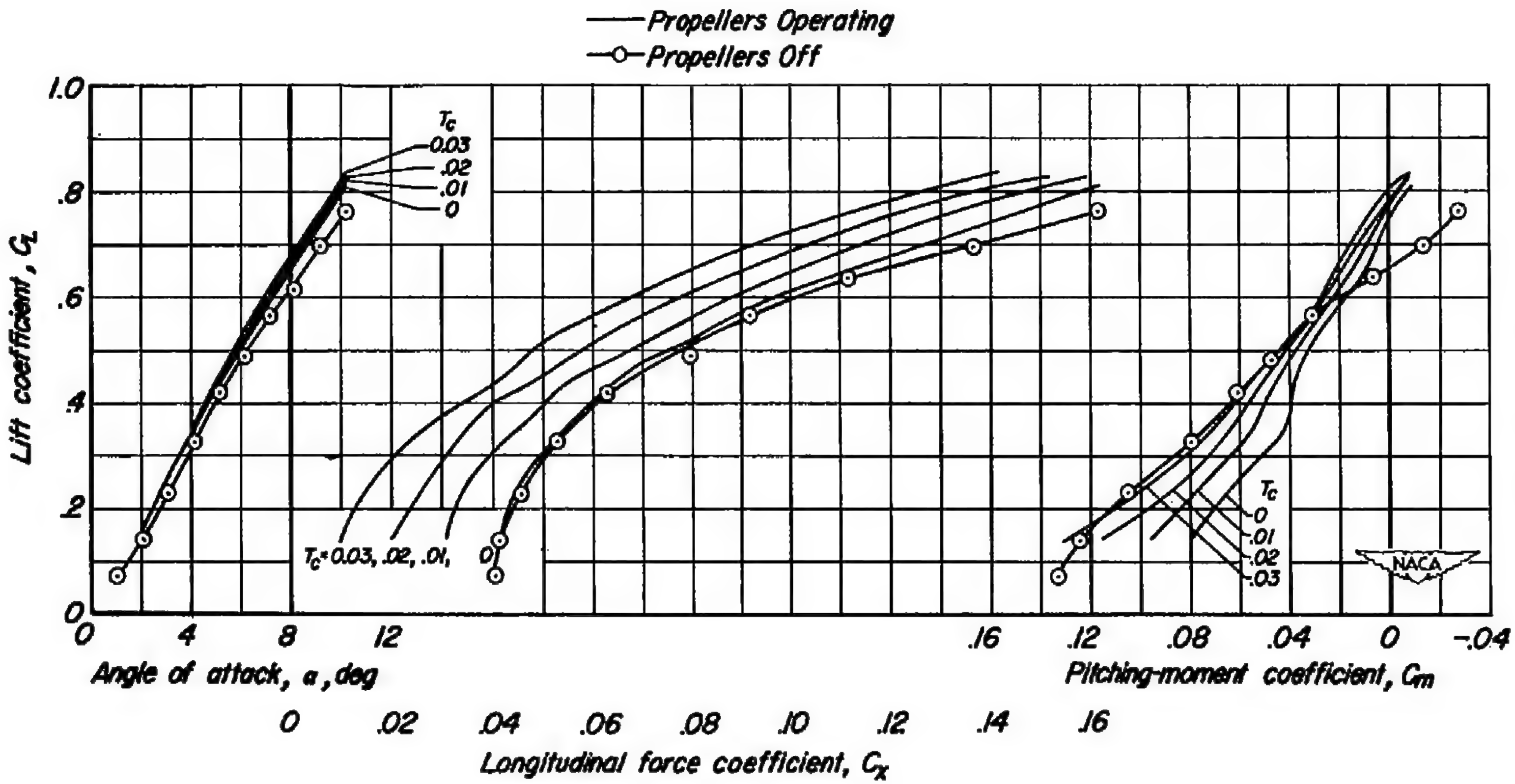
(c) M = 0.83

Figure 8.- Continued.



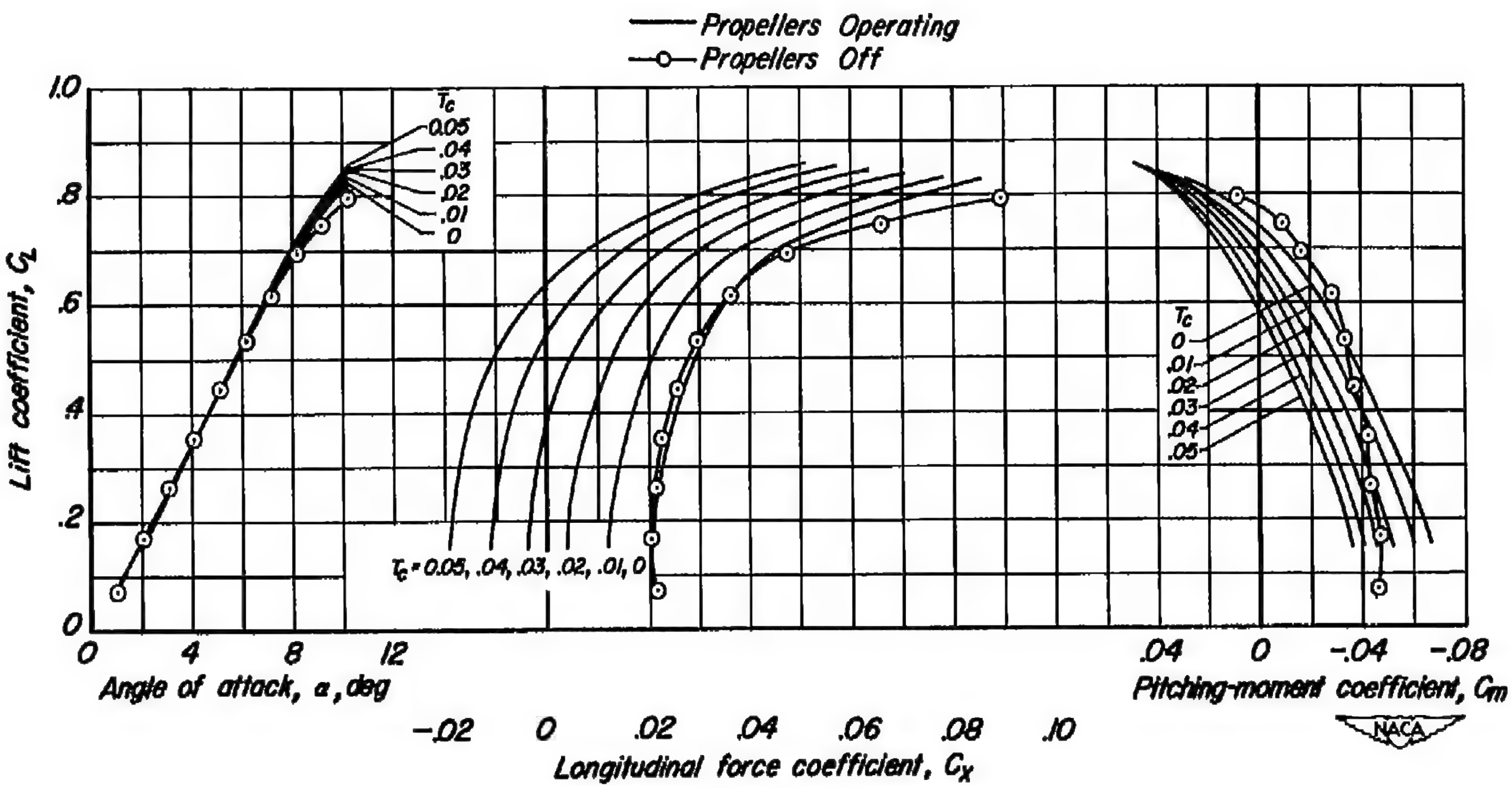
(d) M = 0.86

Figure 8.- Continued.



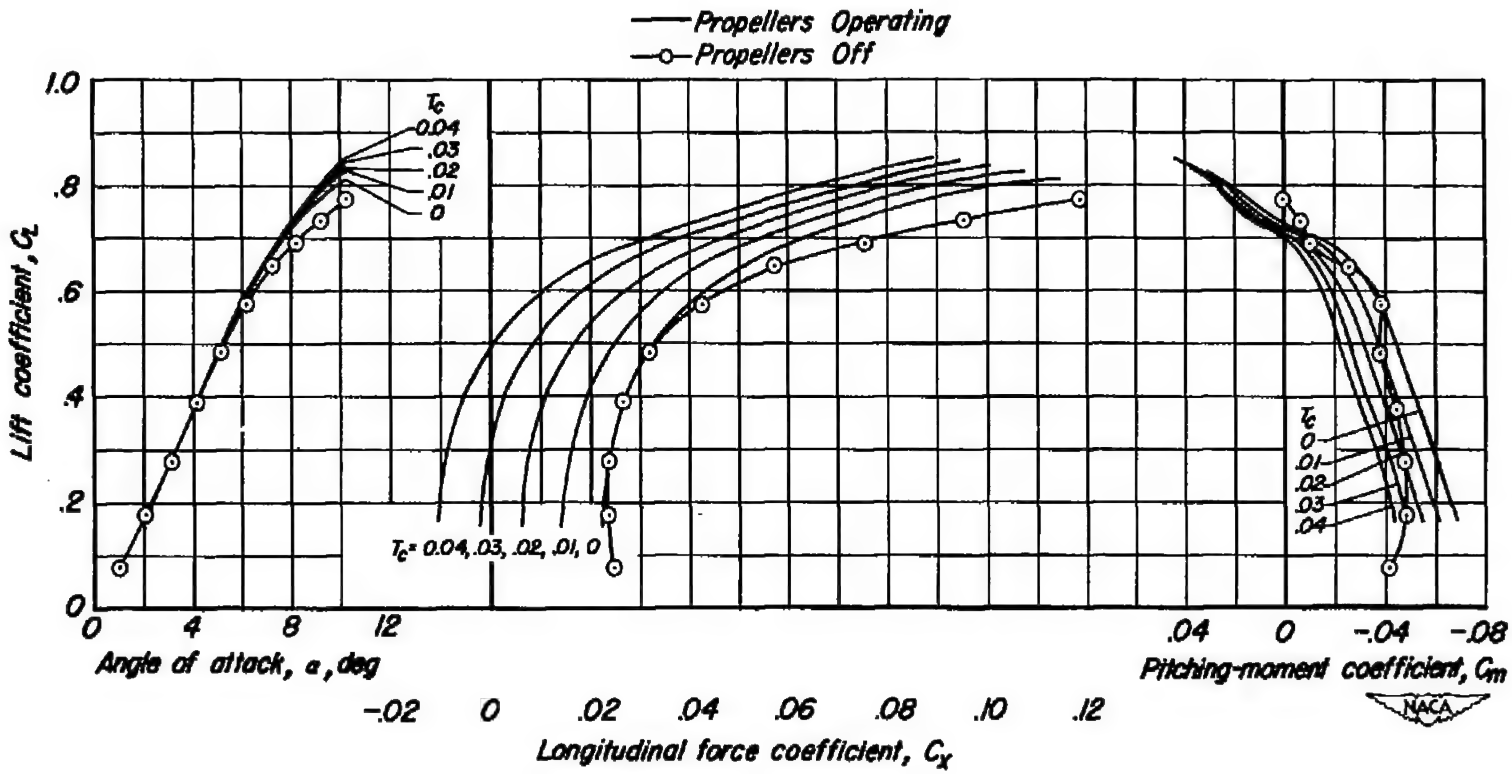
(e) M = 0.90

Figure 8.- Concluded.



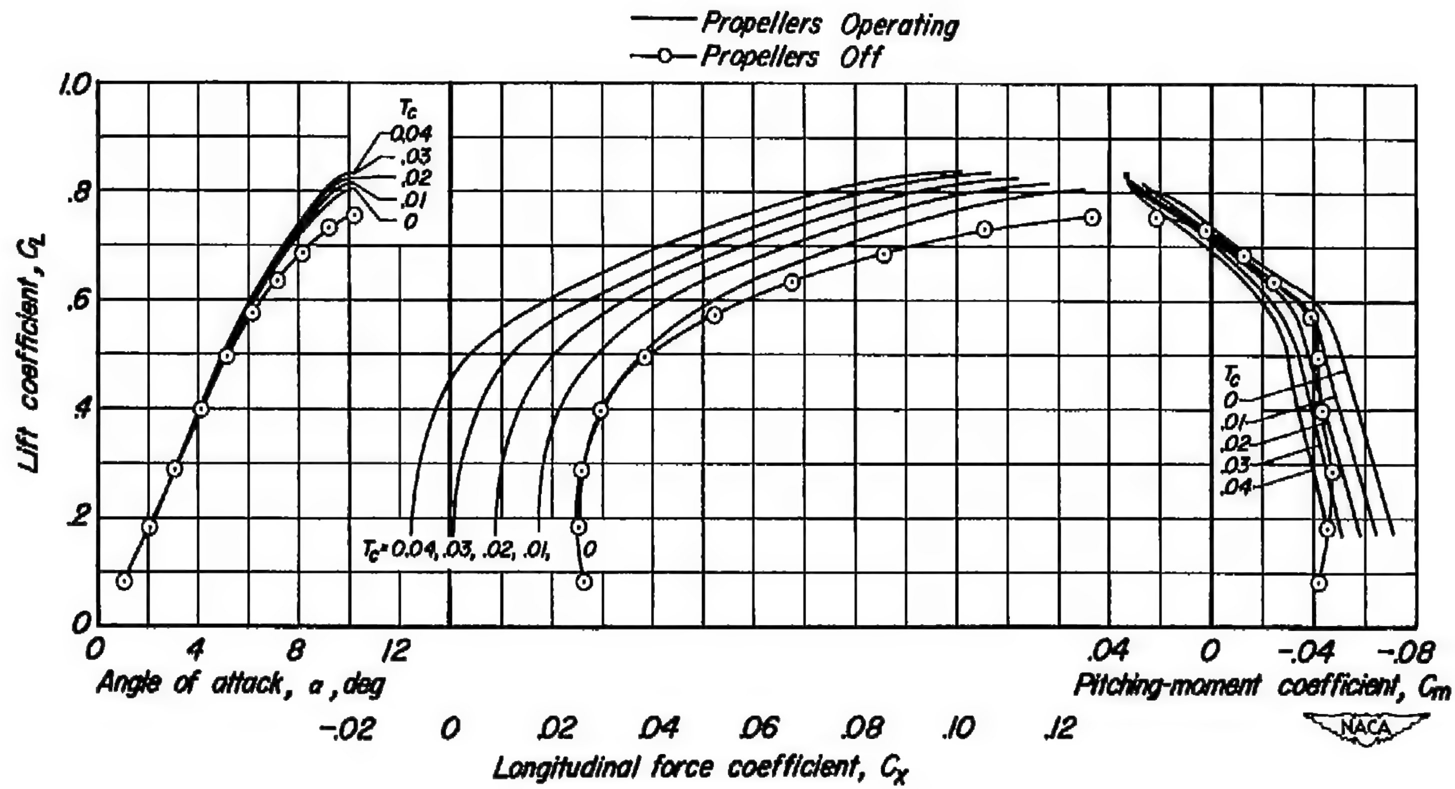
(a) M = 0.70

Figure 9.- The effect of operating propellers on the longitudinal characteristics of the model. Tail off, $\beta = 51^\circ$, $R = 1 \times 10^6$.



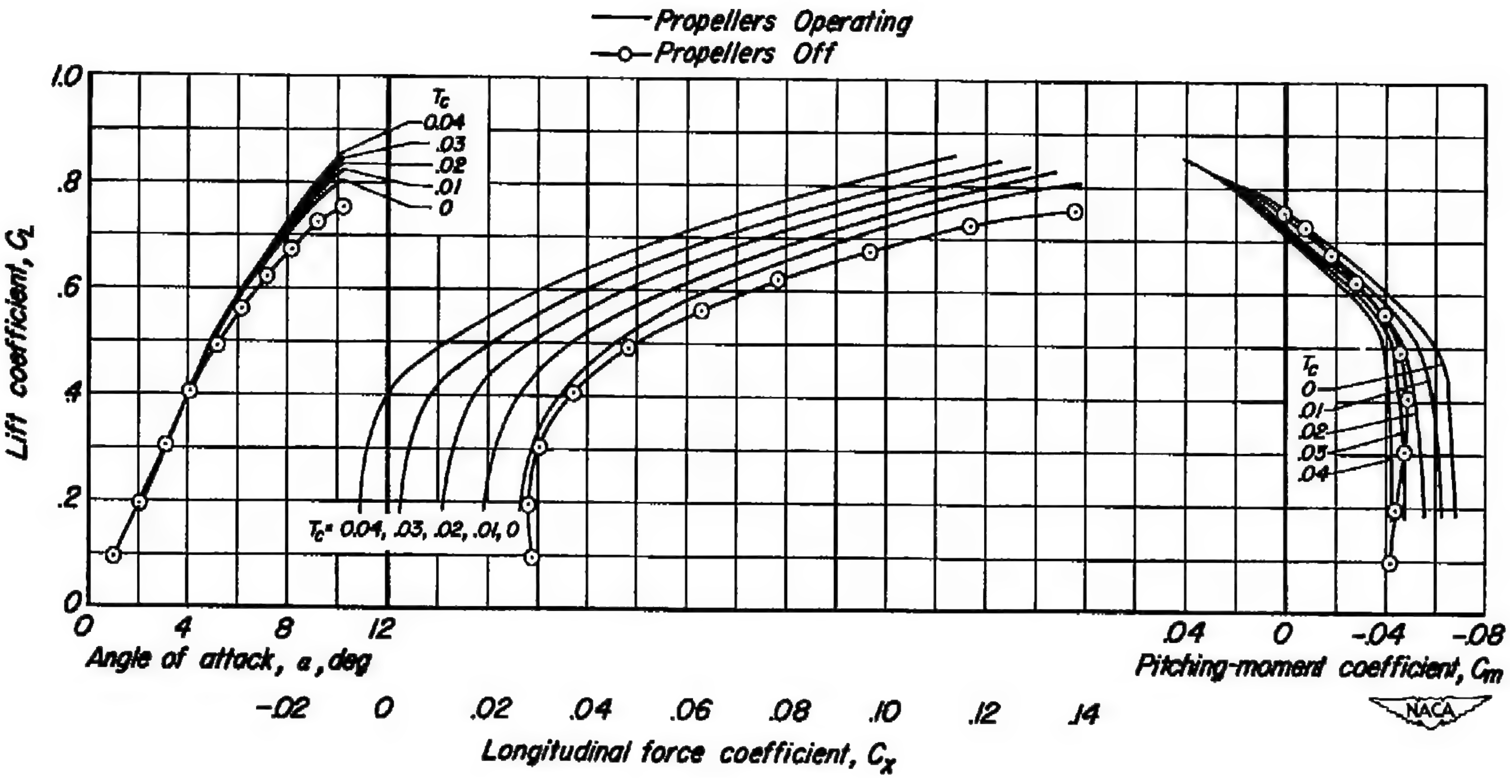
(b) M = 0.80

Figure 9.- Continued.



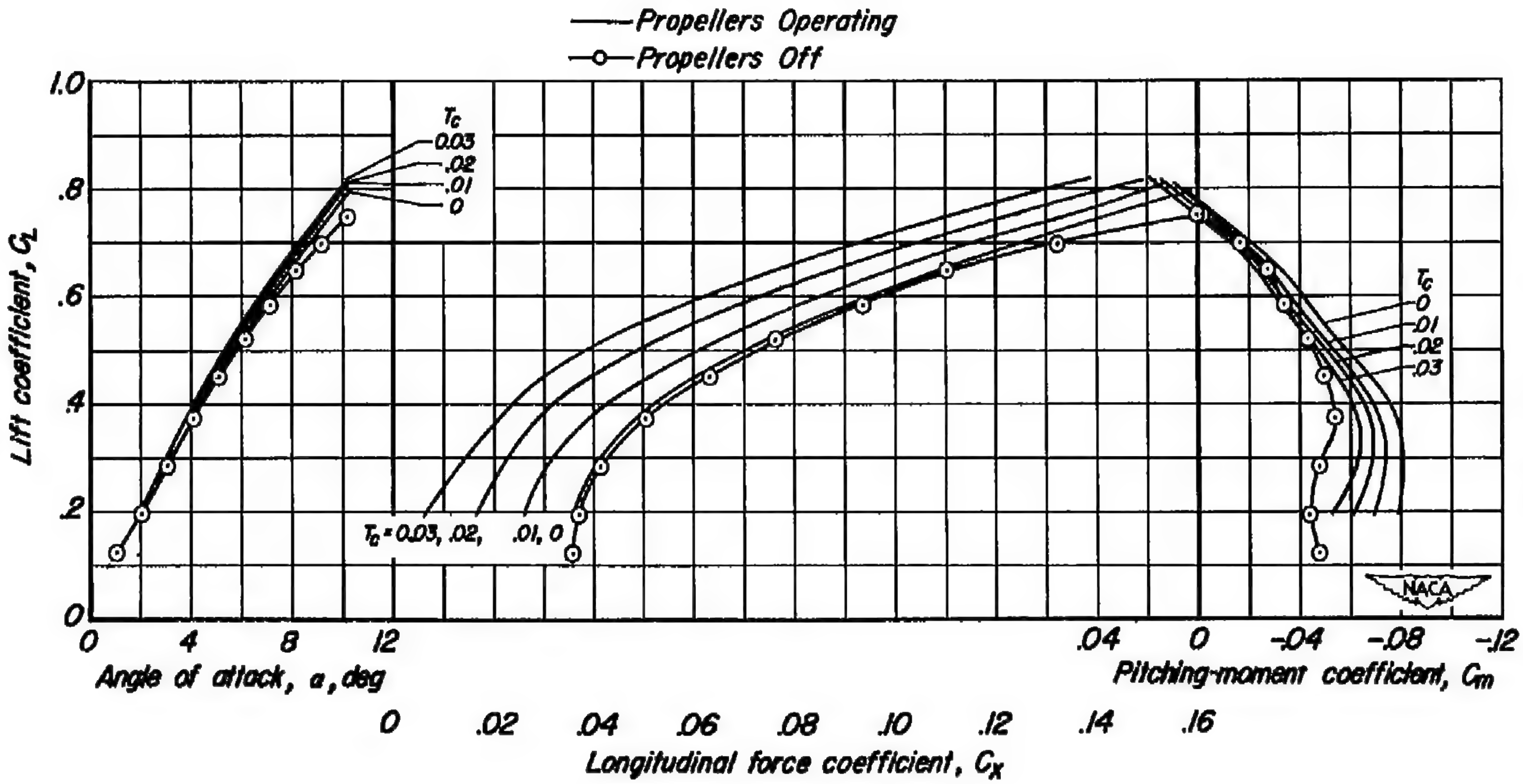
(c) M = 0.83

Figure 9.- Continued.



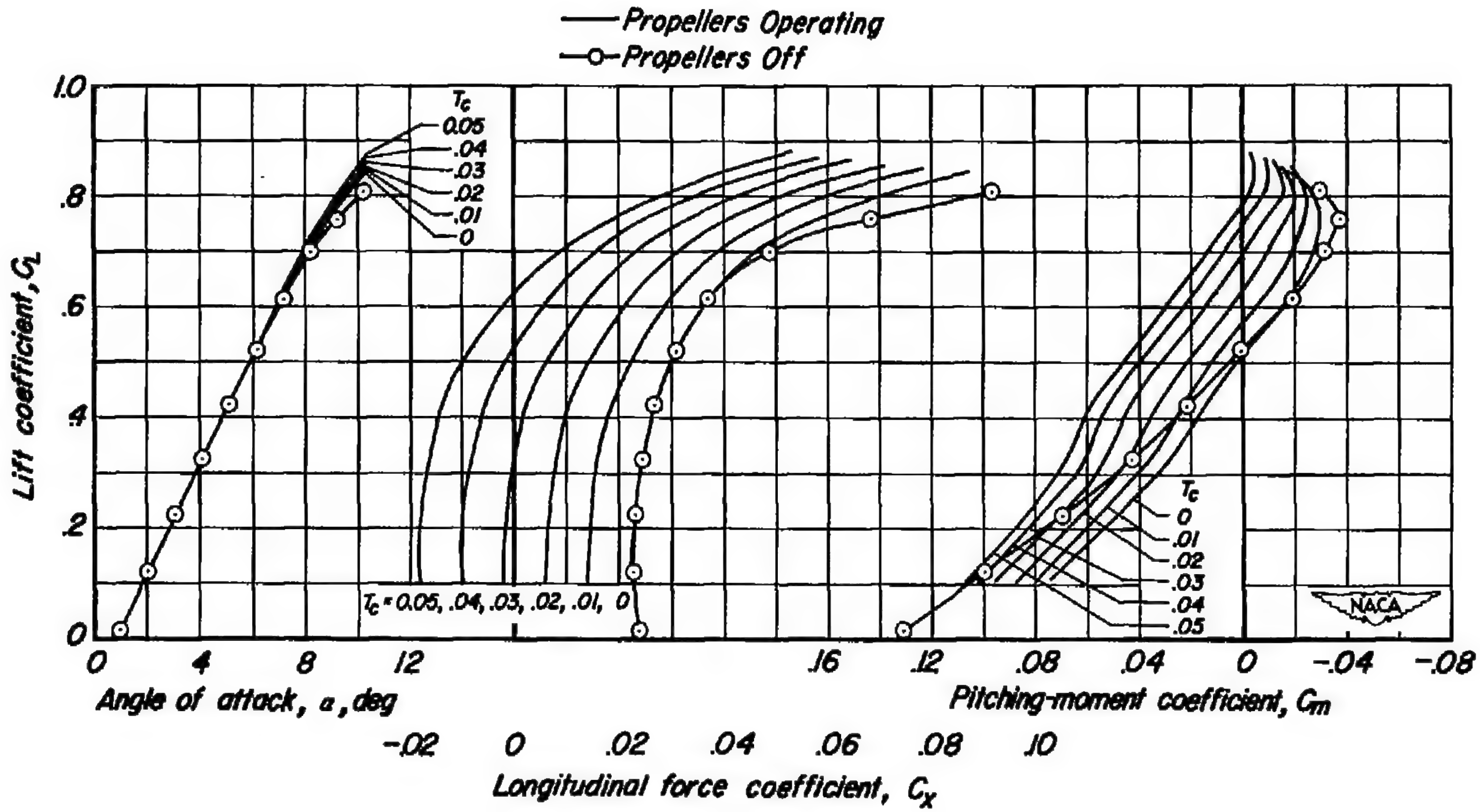
(d) M = 0.86

Figure 9.- Continued.



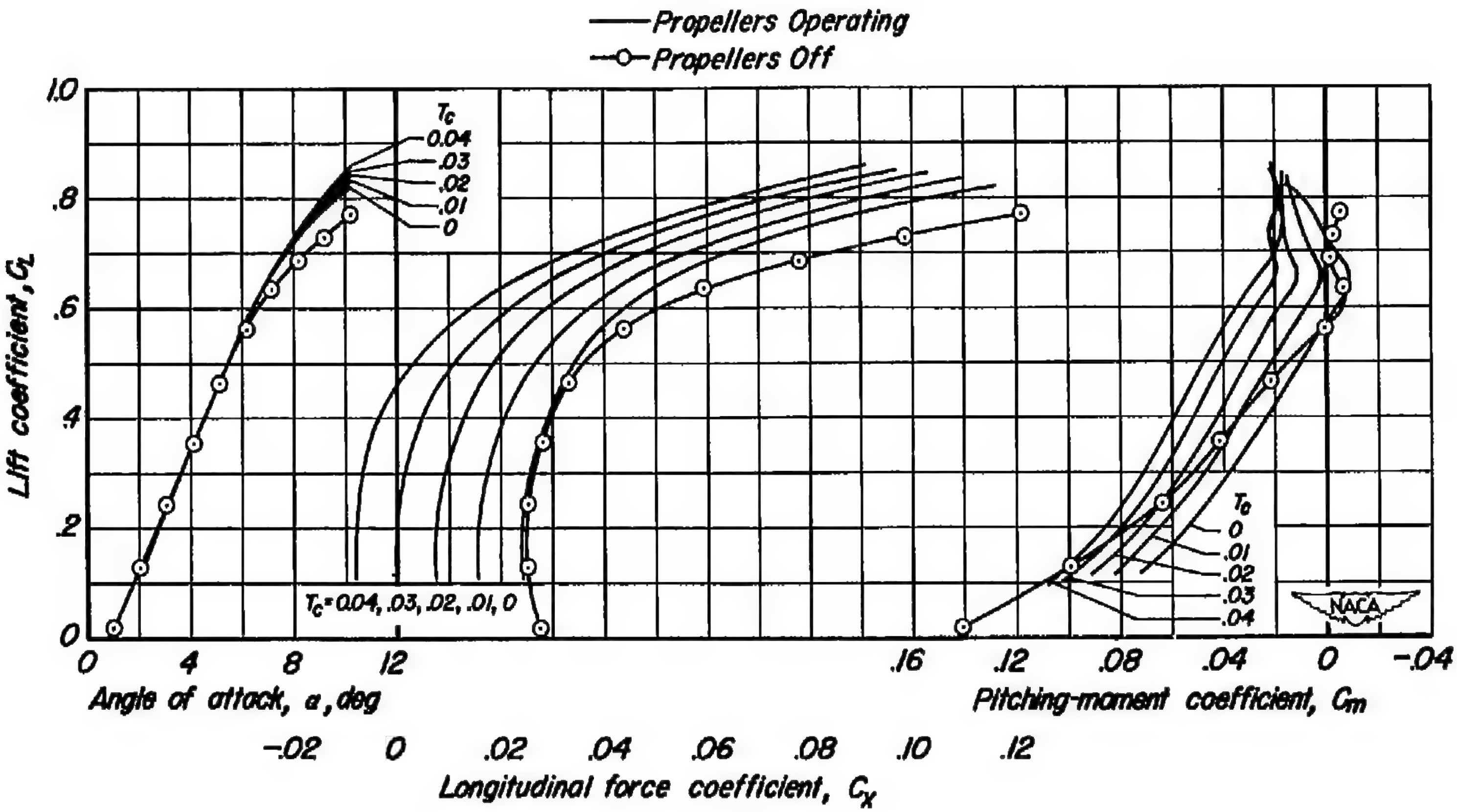
(e) M = 0.90

Figure 9.- Concluded.



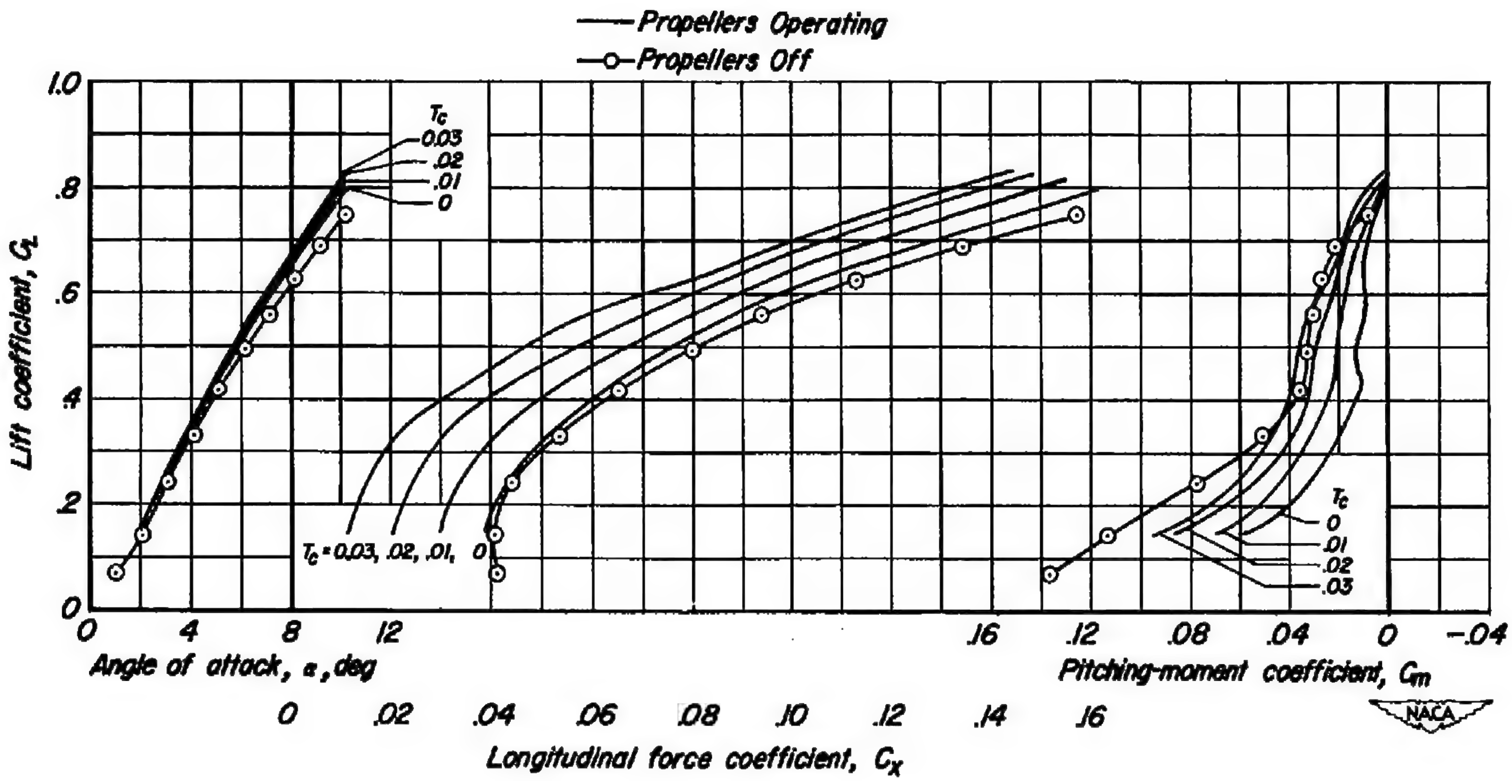
(a) M = 0.70

Figure 10.- The effect of operating propellers on the longitudinal characteristics of the model. Tail height = 0.10 b/2, $i_t = -4^{\circ}$, $\beta = 51^{\circ}$, $R = 1 \times 10^6$.



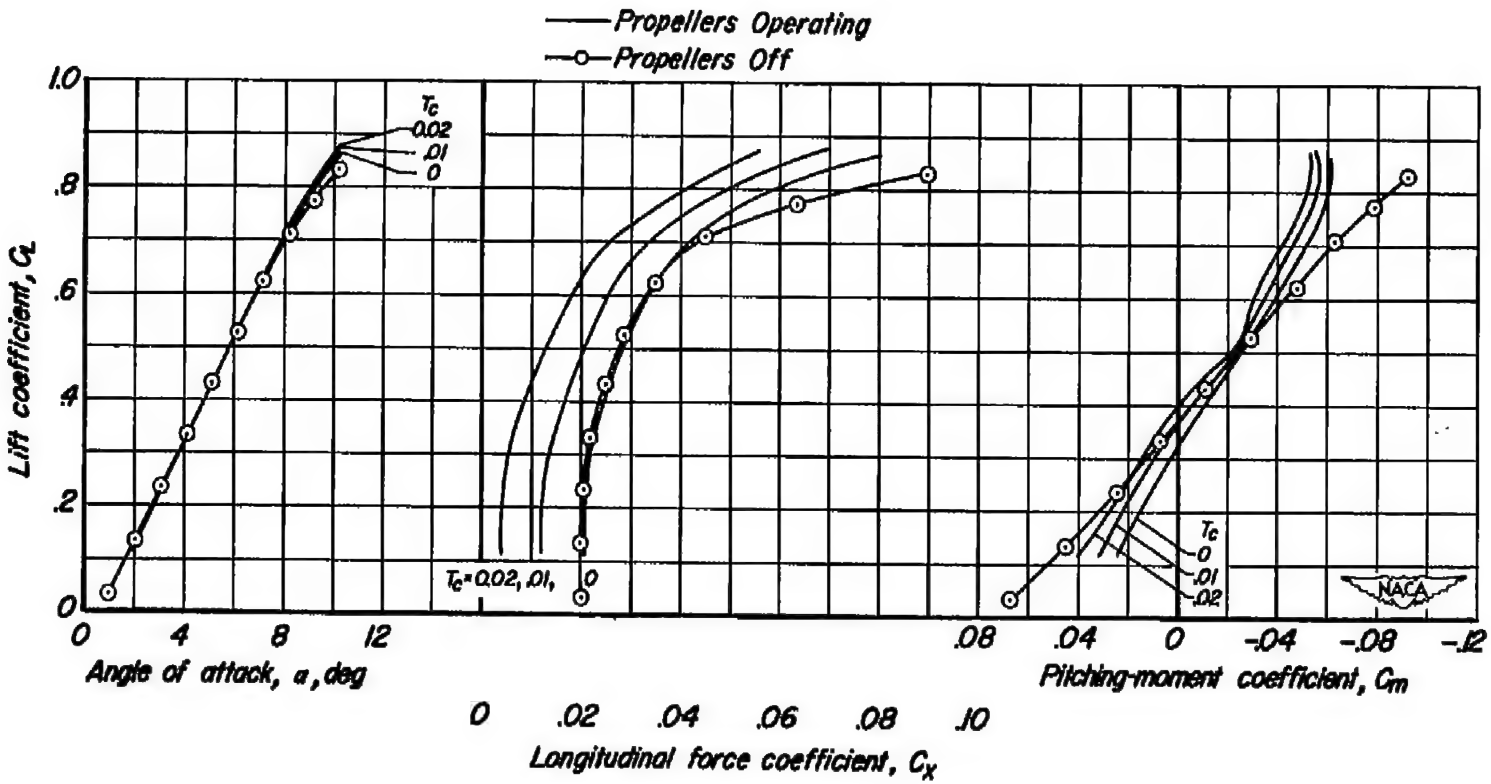
(b) M = 0.80

Figure 10.- Continued.



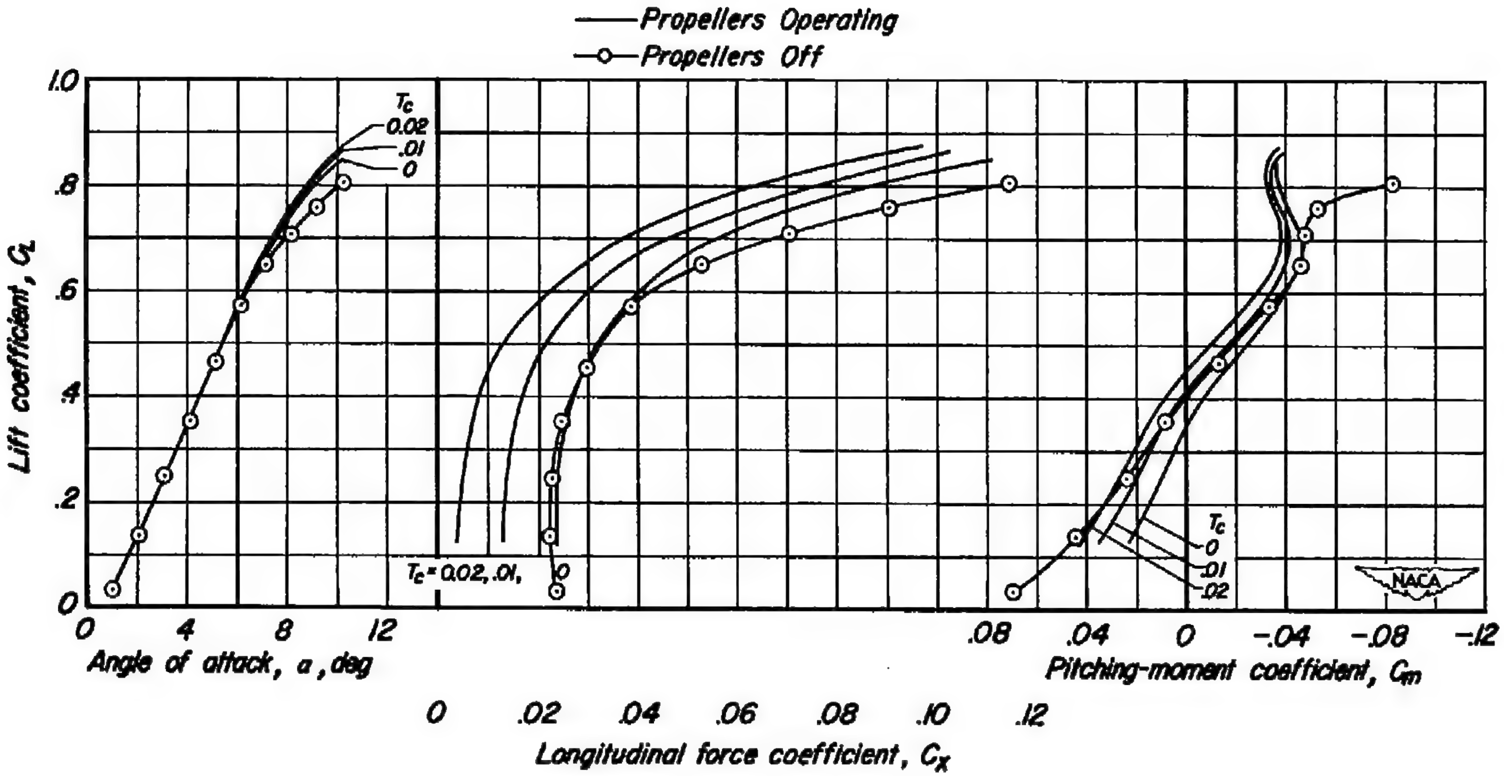
(c) M = 0.90

Figure 10.- Concluded.



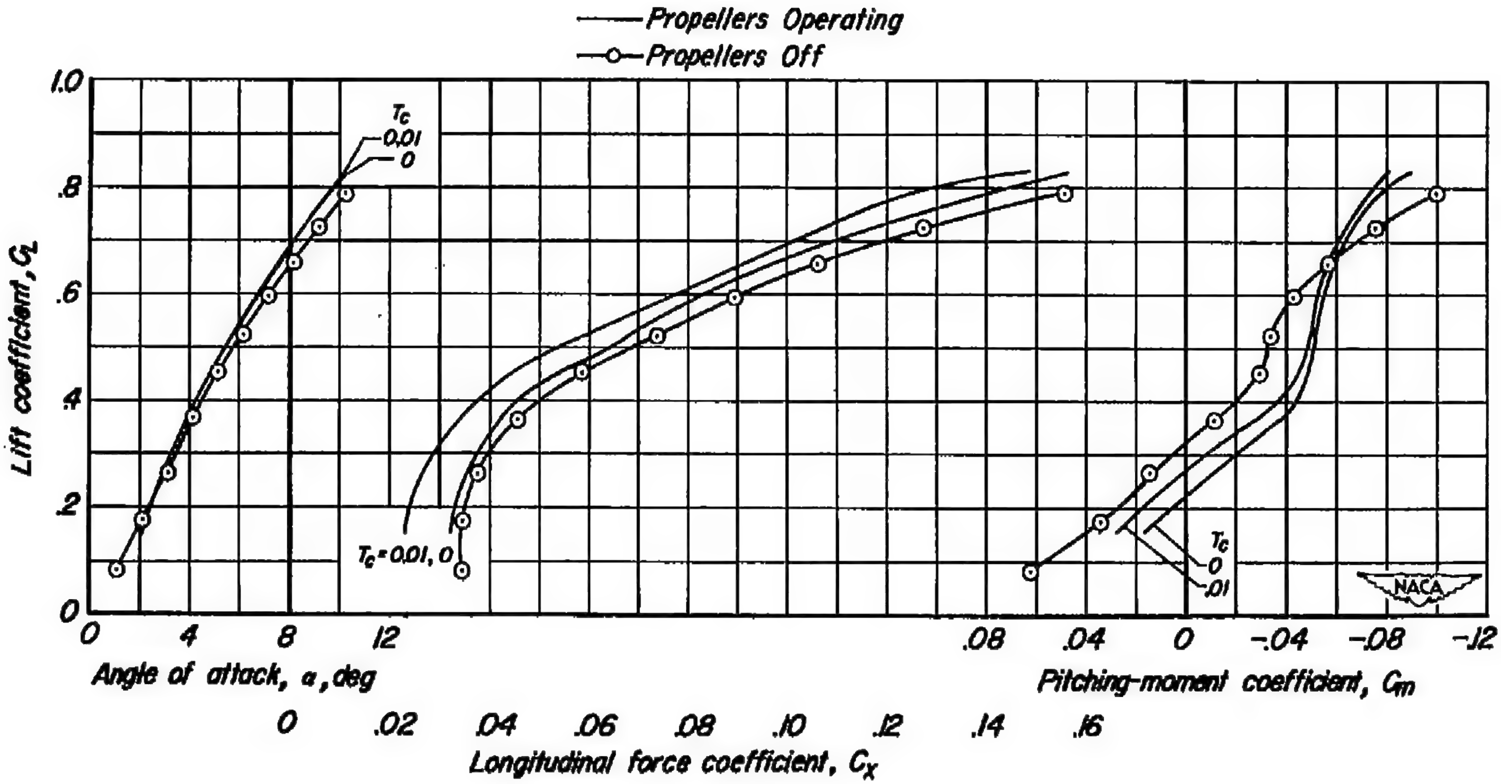
(a) M = 0.70

Figure 11.- The effect of operating propellers on the longitudinal characteristics of the model. Tail height = 0 b/2, $i_t = -4^\circ$, $\beta = 51^\circ$, $R = 2 \times 10^6$.



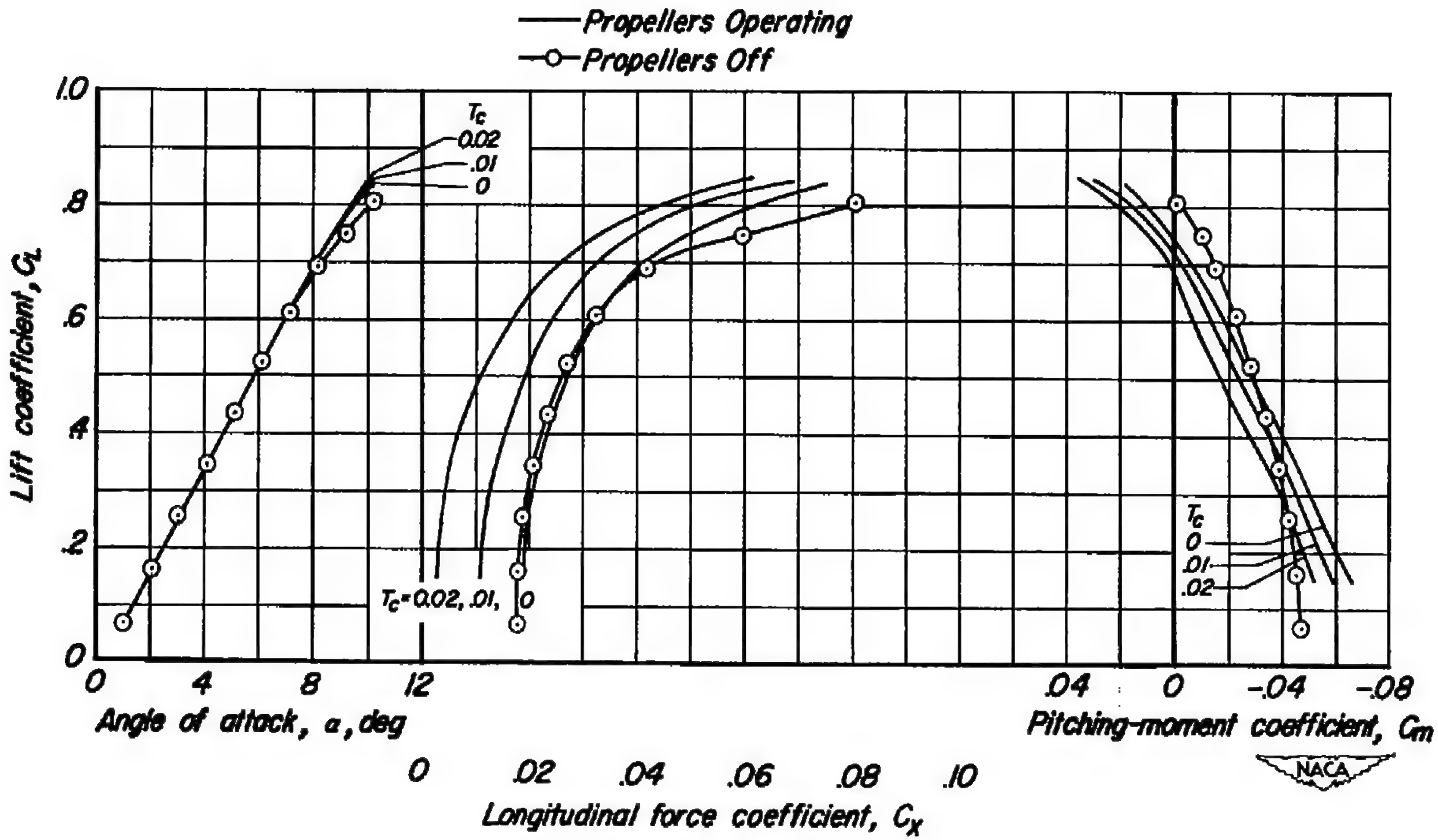
(b) M = 0.80

Figure 11.- Continued.



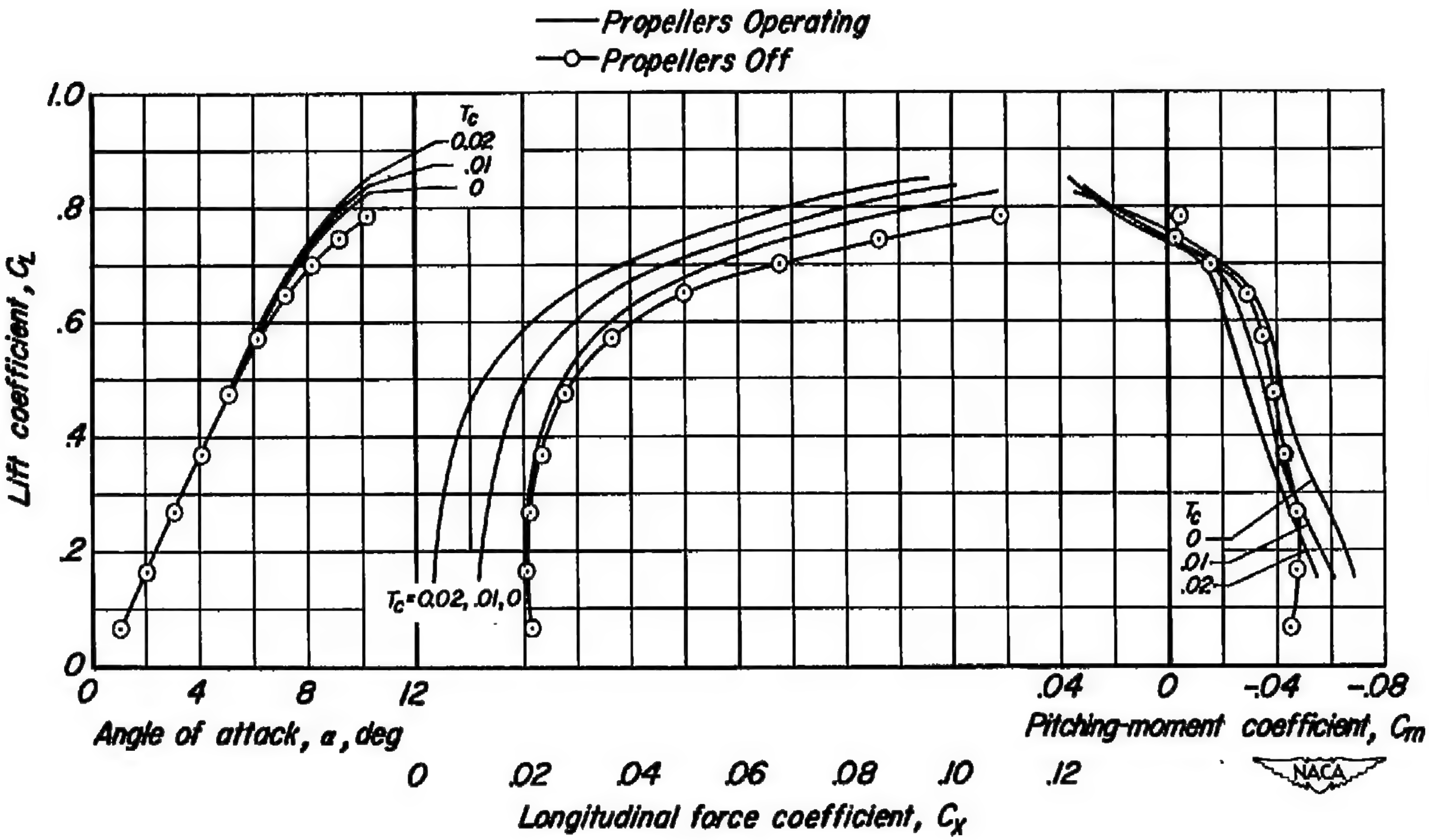
(c) M = 0.90

Figure 11.- Concluded.



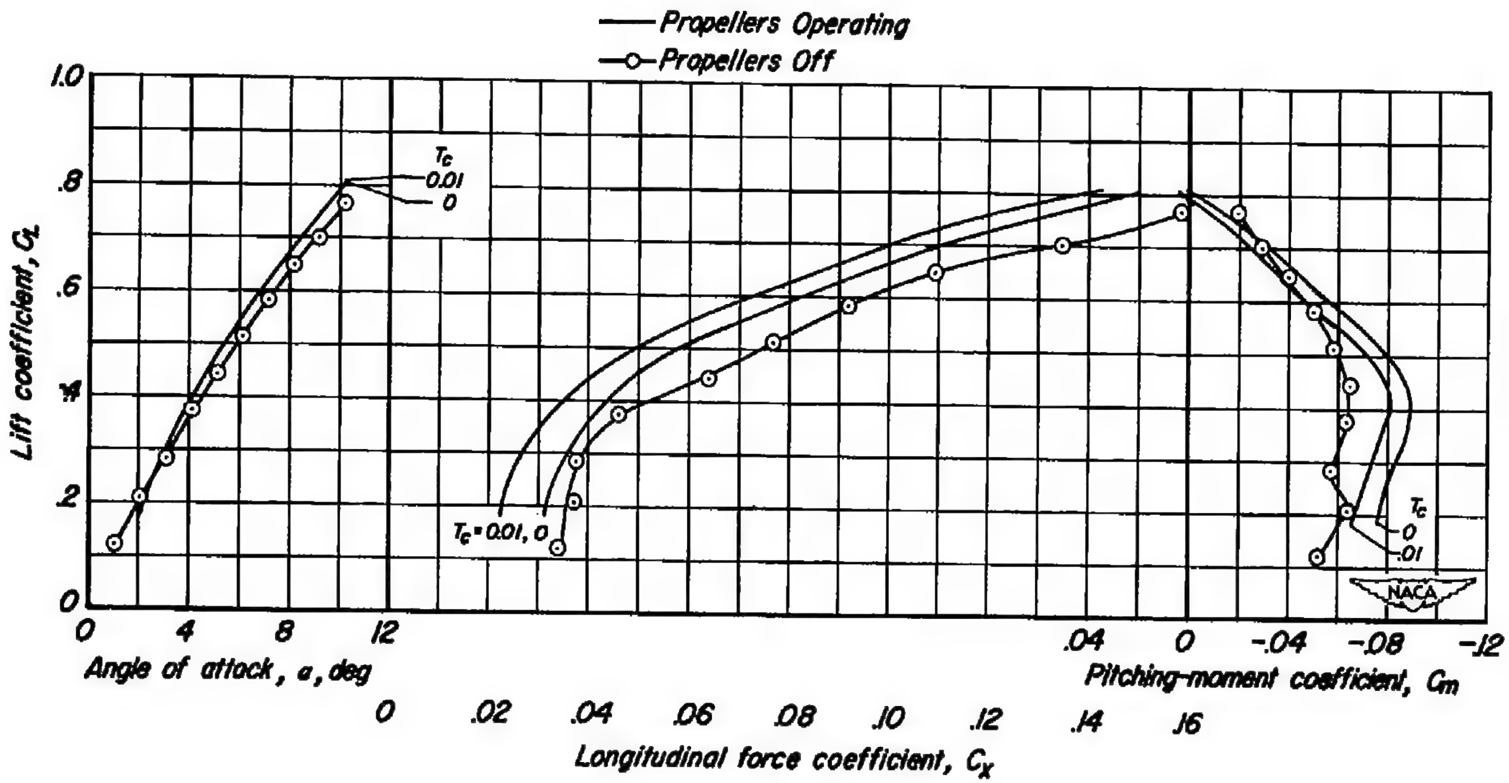
(a) M = 0.70

Figure 12.- The effect of operating propellers on the longitudinal characteristics of the model. Tail off, $\beta = 51^{\circ}$, $R = 2 \times 10^{6}$.



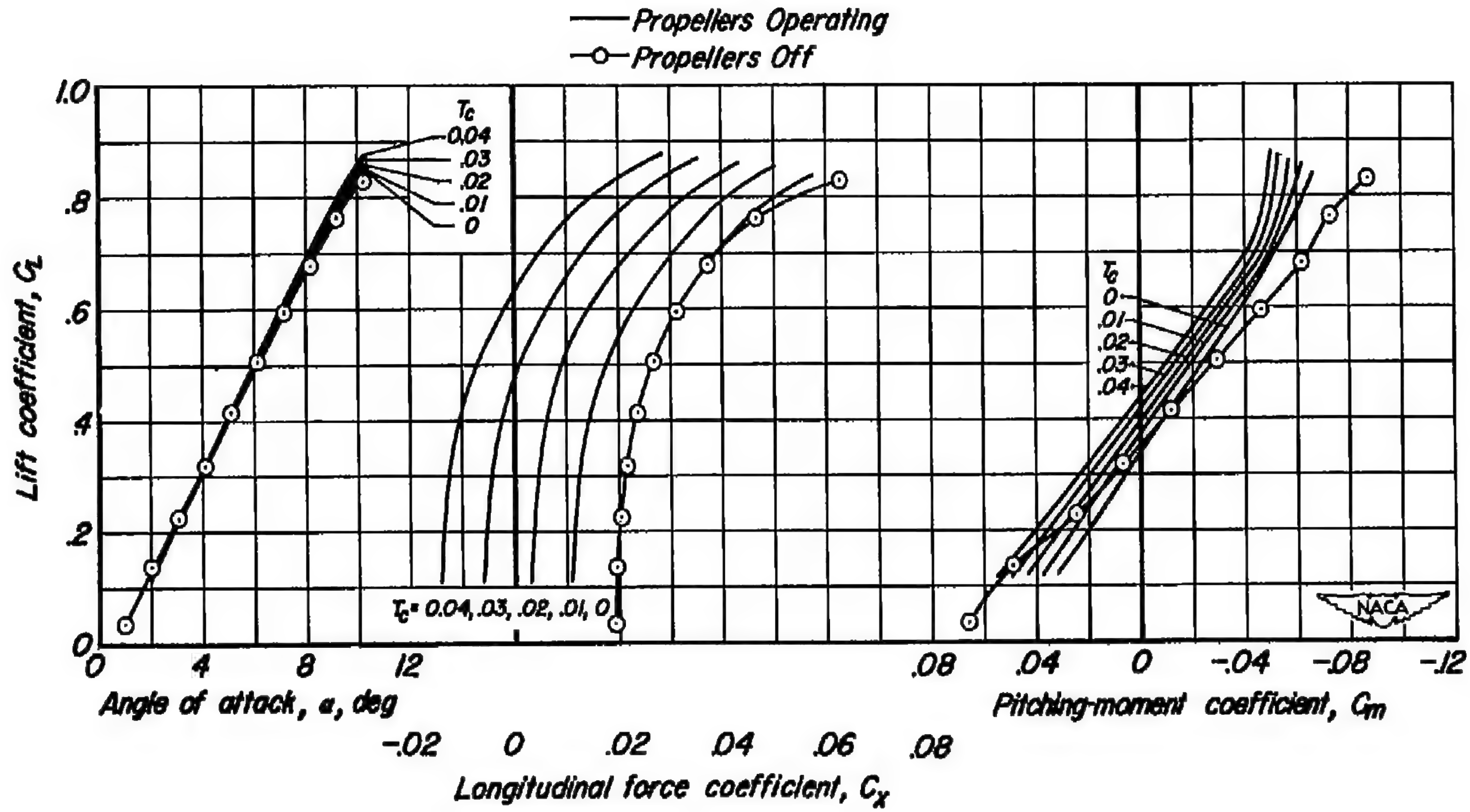
(b) M = 0.80

Figure 12.- Continued.



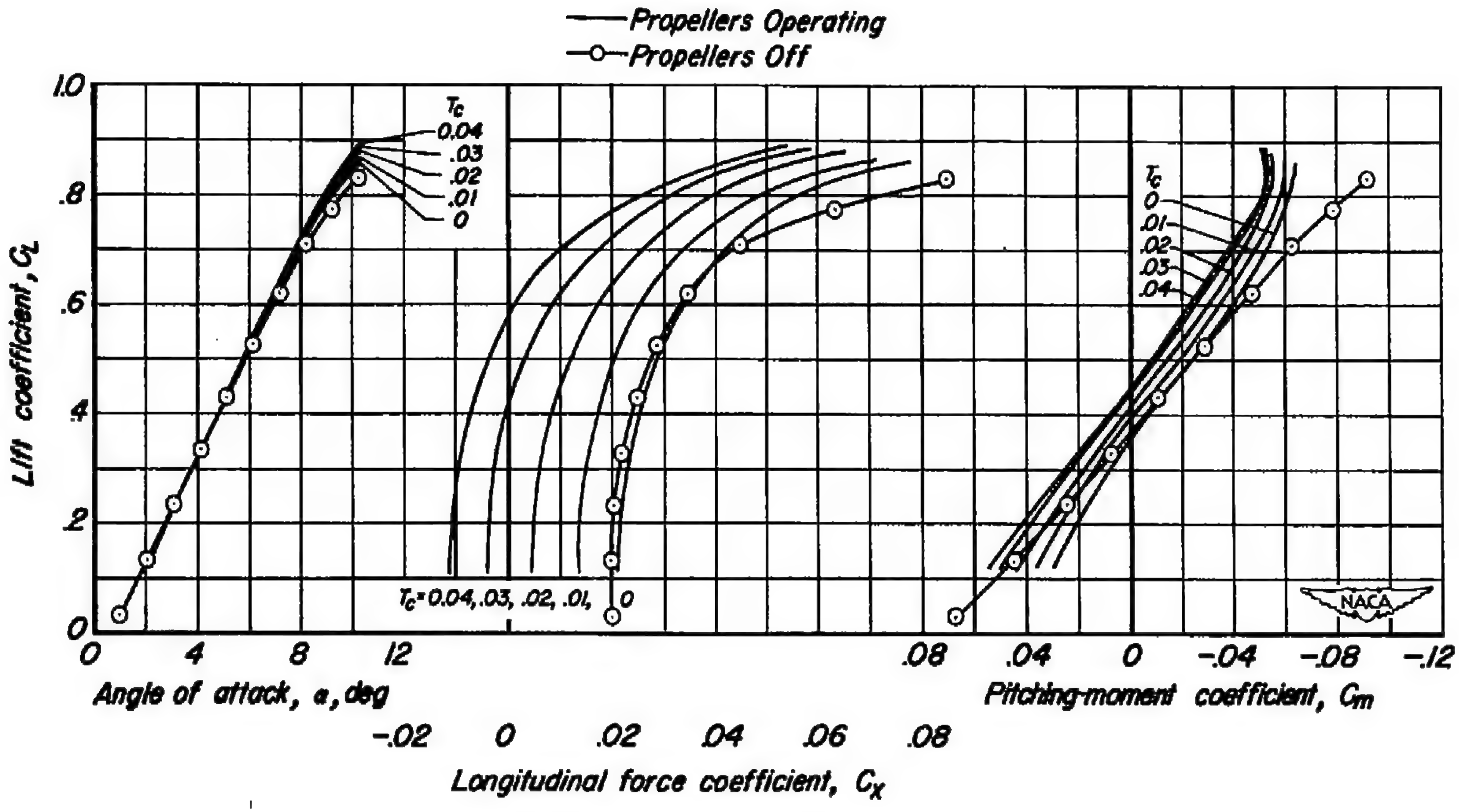
(c) M = 0.90

Figure 12.- Concluded.



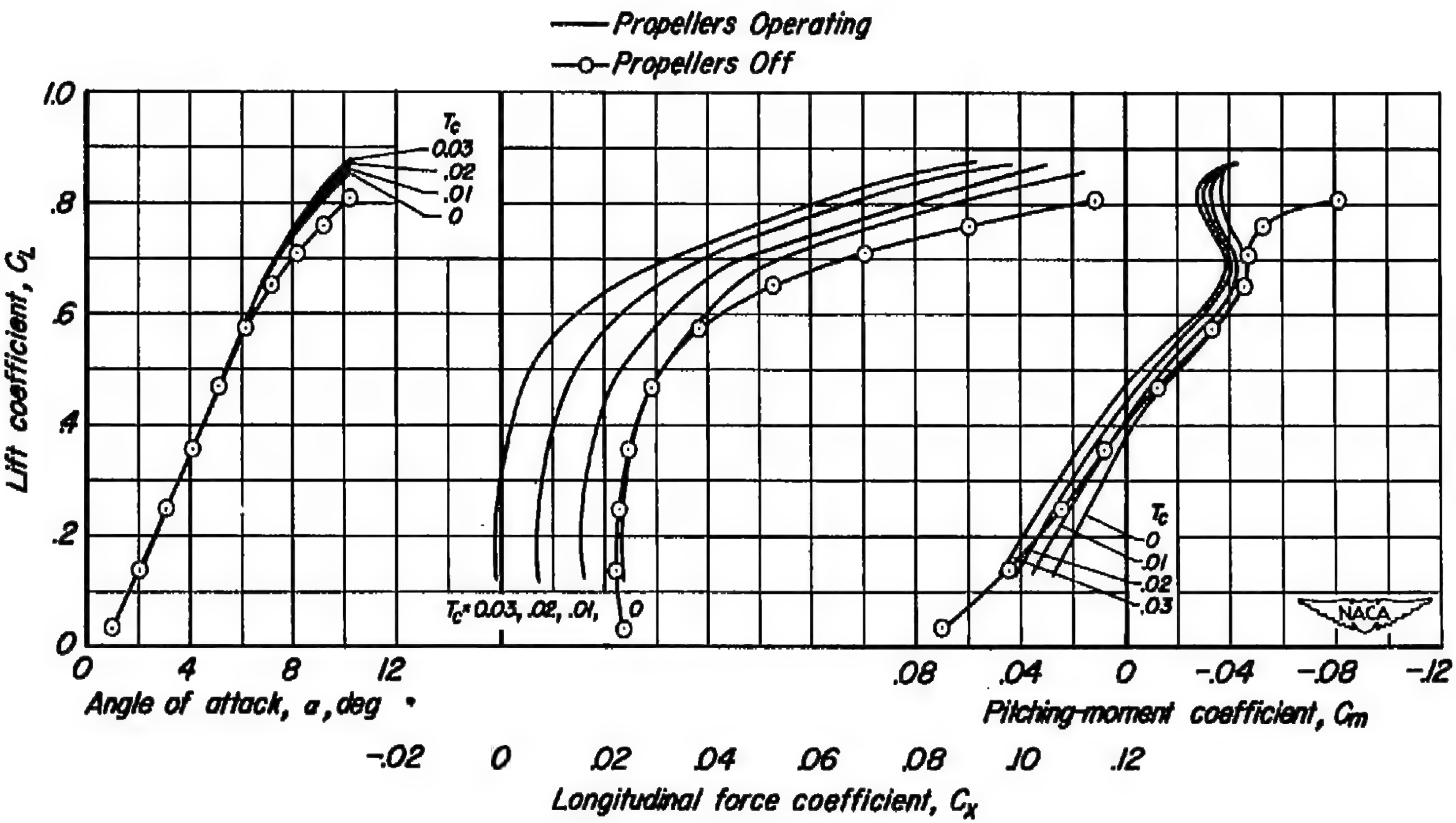
(a) M = 0.60

Figure 13.- The effect of operating propellers on the longitudinal characteristics of the model. Tail height = 0 b/2, $i_t = -4^\circ$, $\beta = 41^\circ$, $R = 2 \times 10^6$.



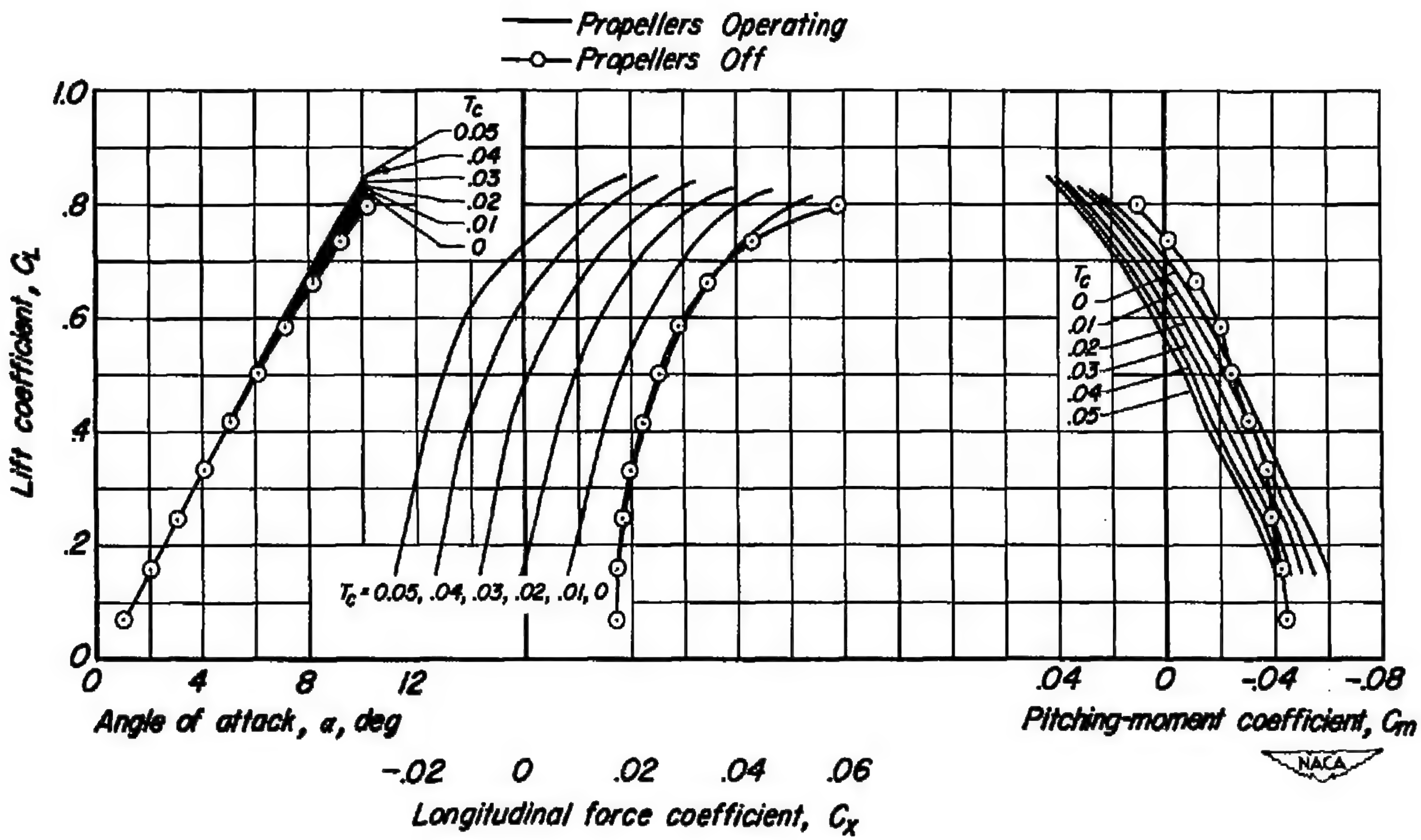
(b) M = 0.70

Figure 13.- Continued.



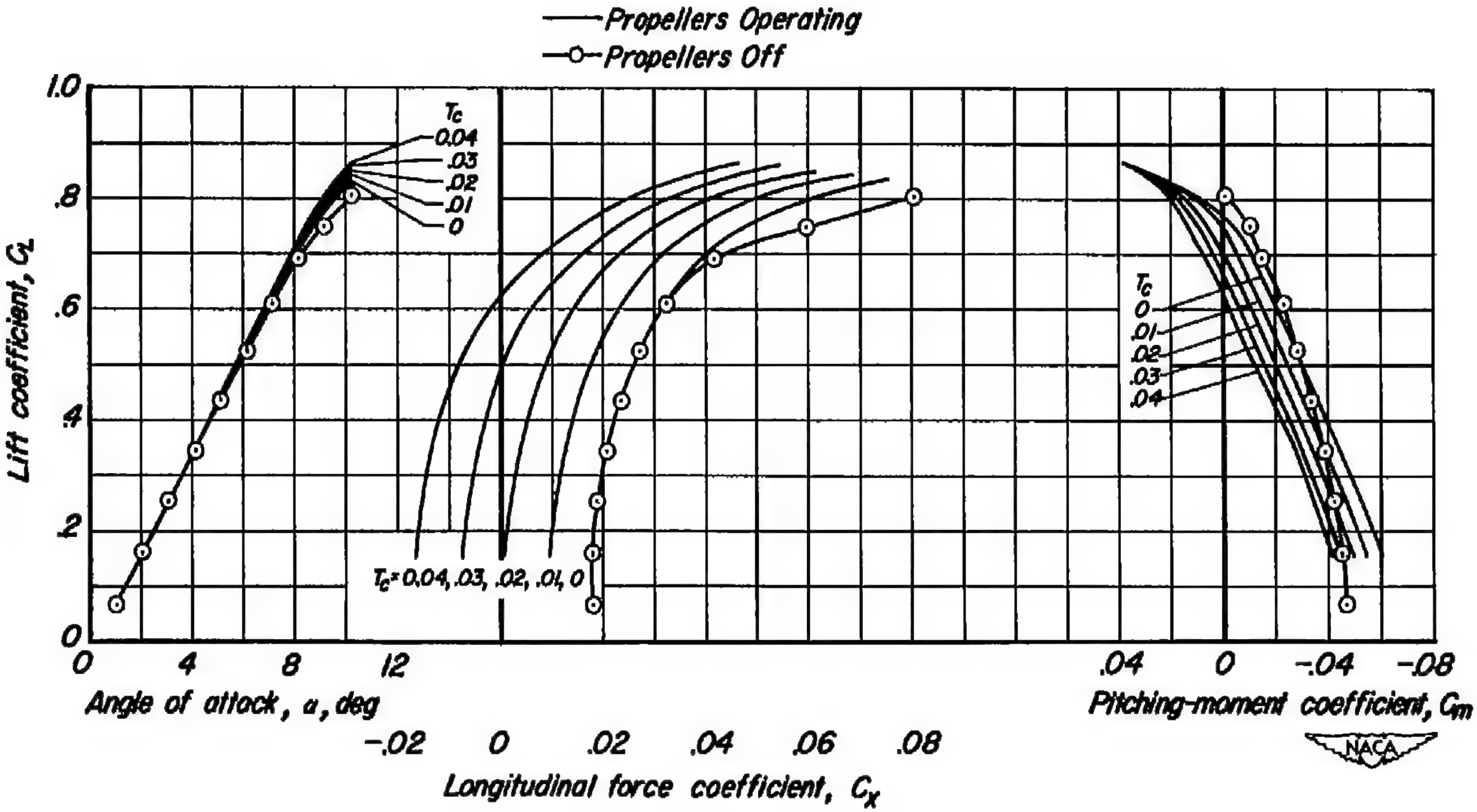
(c) M = 0.80

Figure 13.- Concluded.



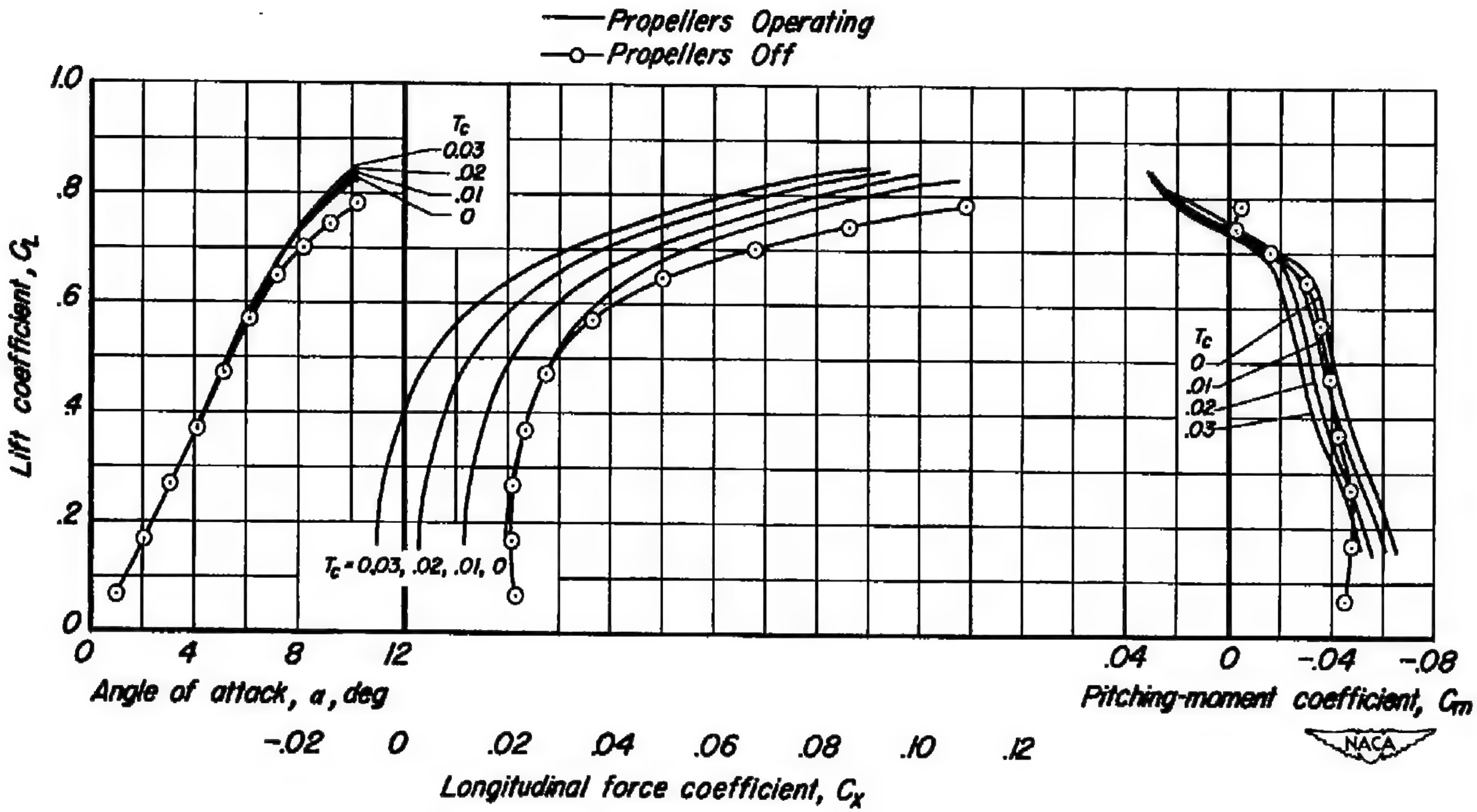
(a) M = 0.60

Figure 14.- The effect of operating propellers on the longitudinal characteristics of the model. Tail off, $\beta = 41^{\circ}$, $R = 2 \times 10^{6}$.



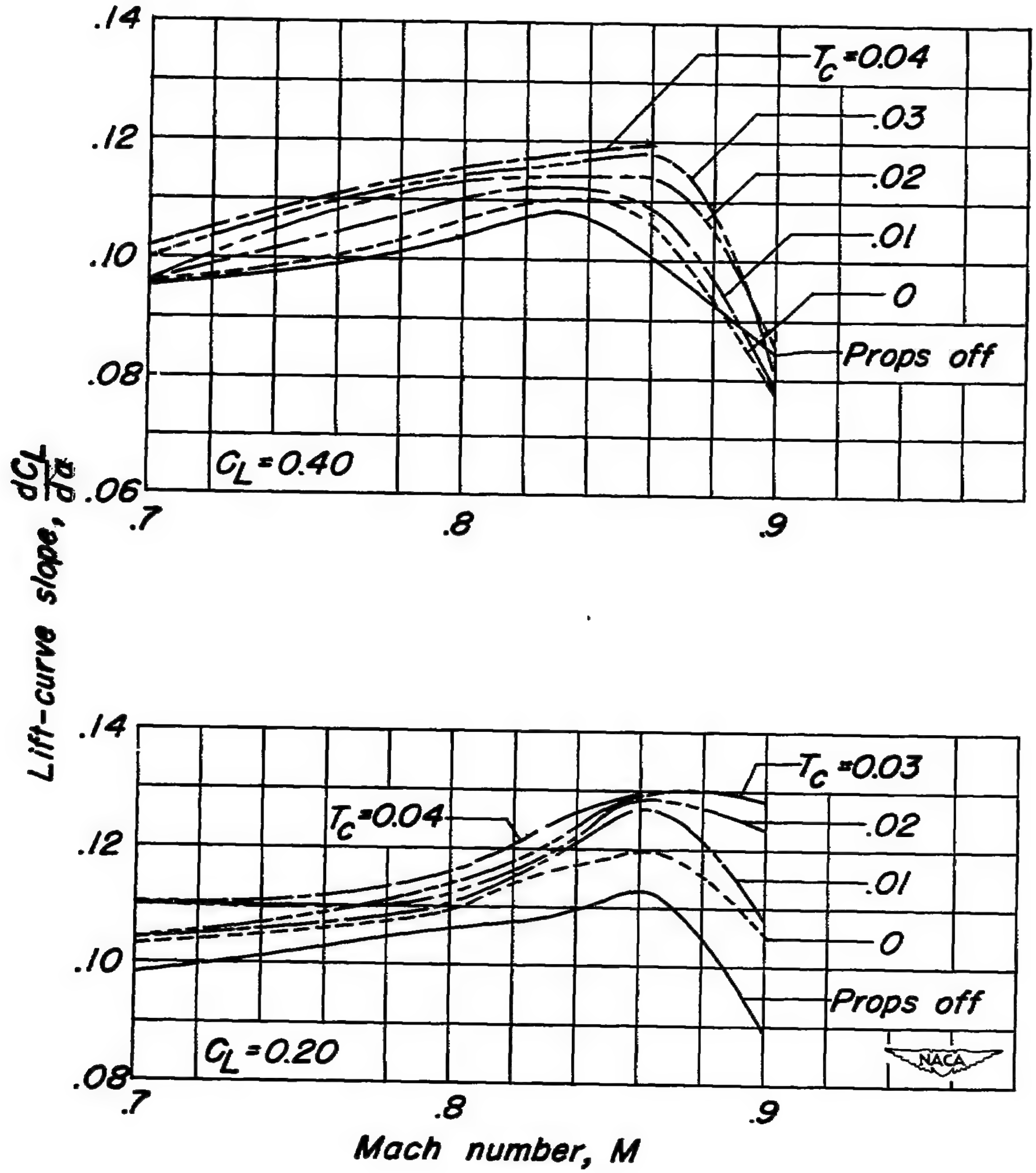
(b) M = 0.70

Figure 14.- Continued.



(c) M = 0.80

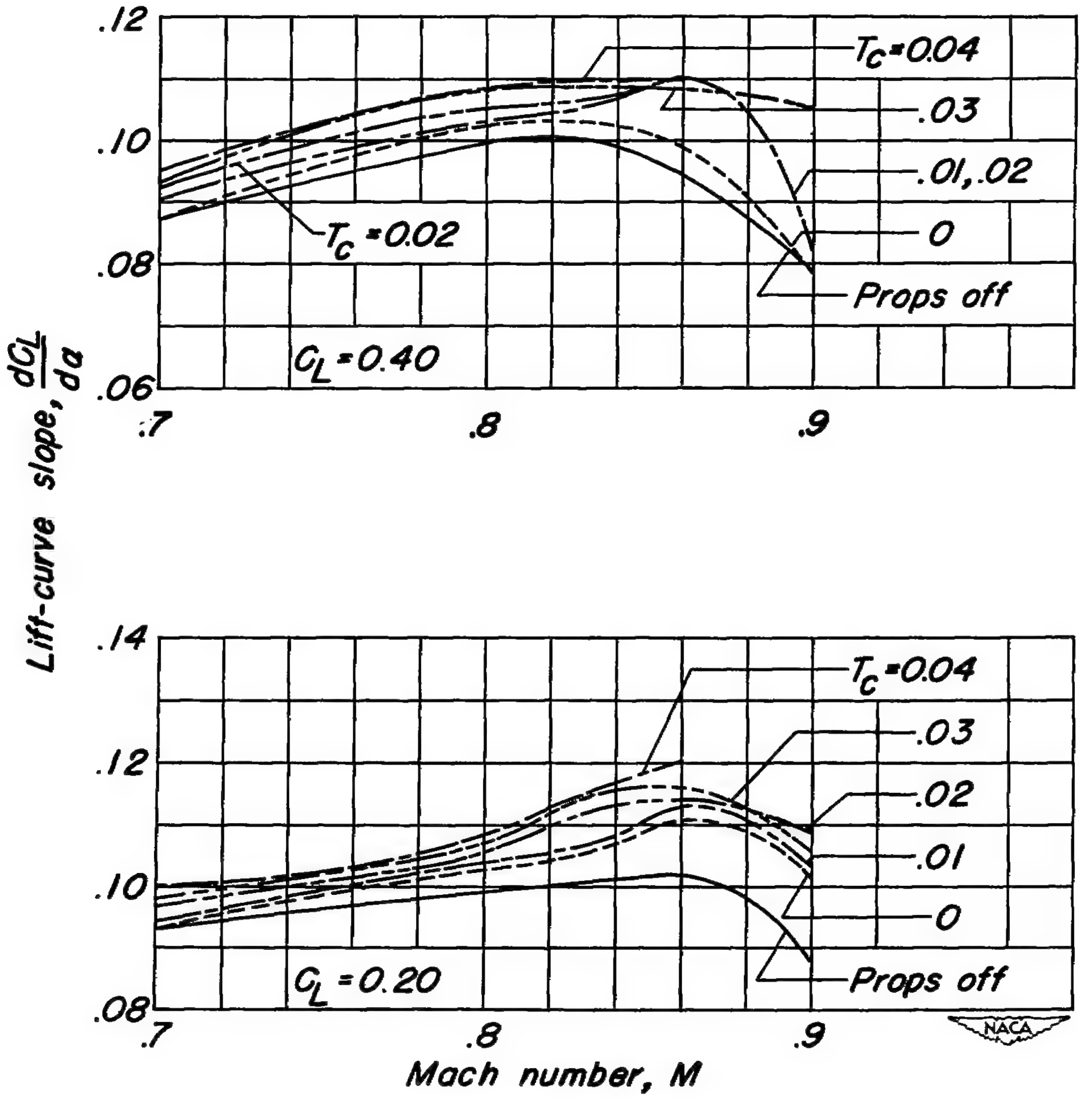
Figure 14.- Concluded.



(a) Tail height = 0 b/2, i_t = -4°.

Figure 15.- The effect of Mach number at constant lift coefficient on the lift-curve slopes of the model with and without operating propellers. $\beta = 51^\circ$, $R = 1 \times 10^6$.

[redacted]



(b) Tail off.

Figure 15.- Concluded.

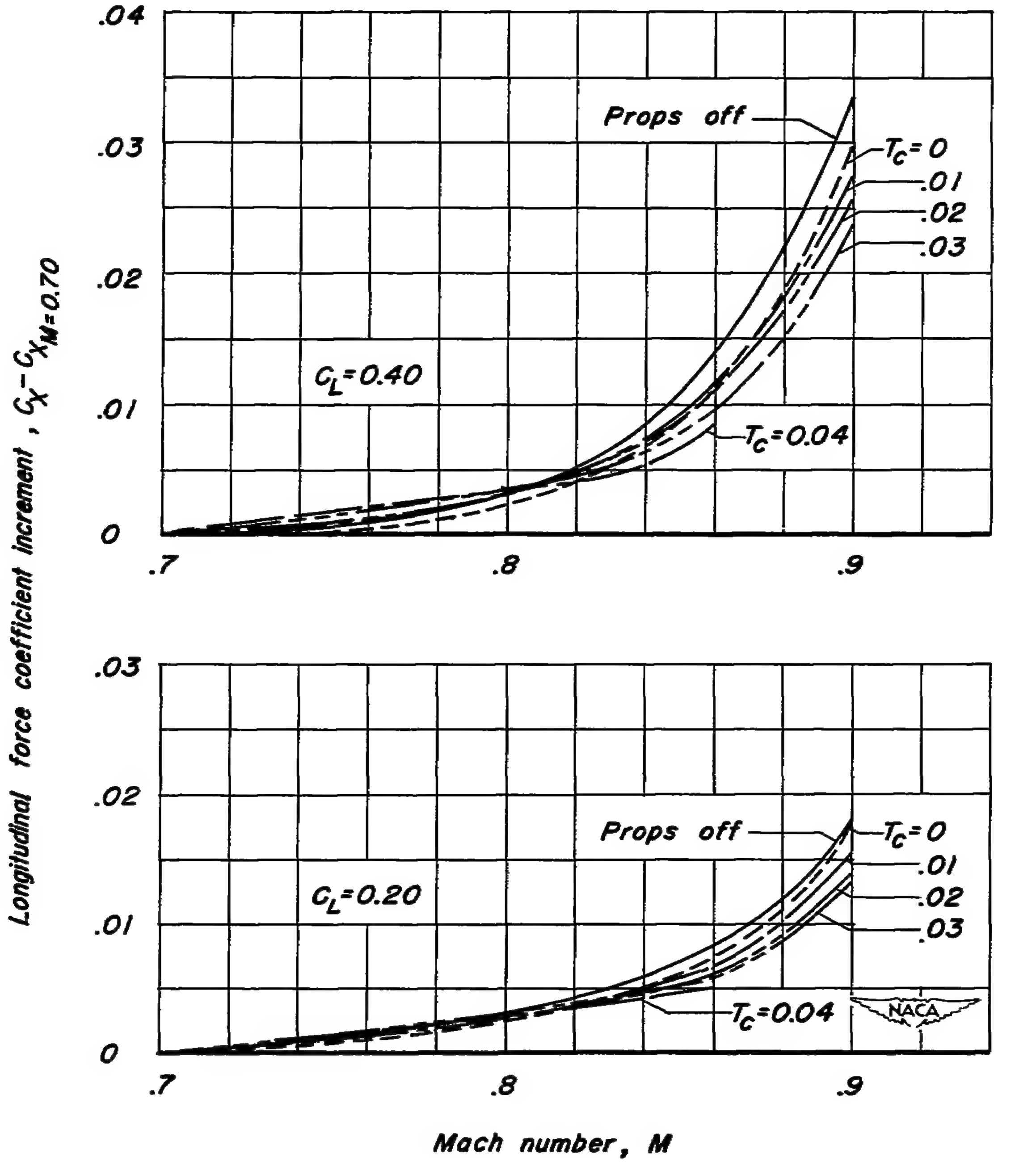
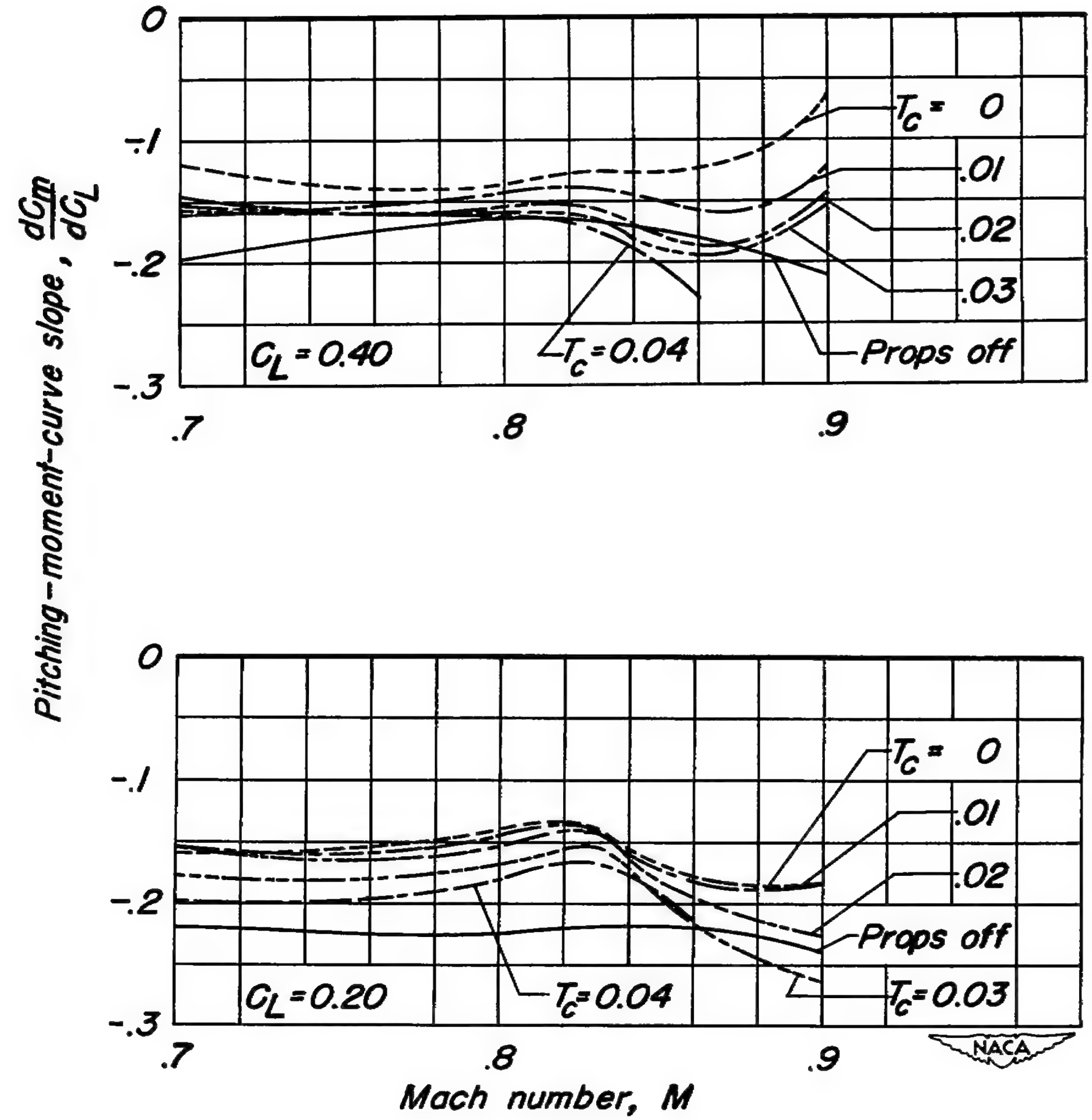
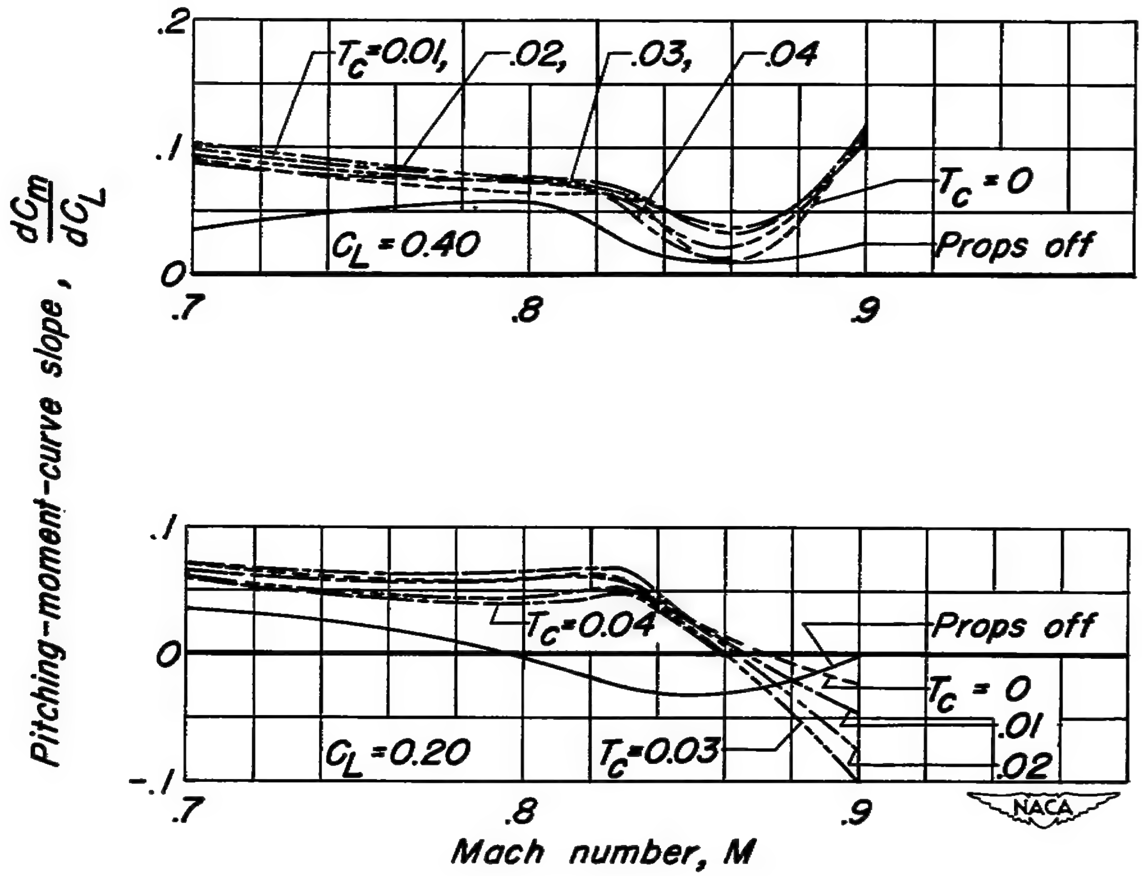


Figure 16.- The effect of Mach number at constant lift coefficient on the longitudinal force coefficient increment of the model with and without operating propellers. Tail height = 0 b/2, $i_t = -4^\circ$, $\beta = 51^\circ$, $R = 1 \times 10^6$.



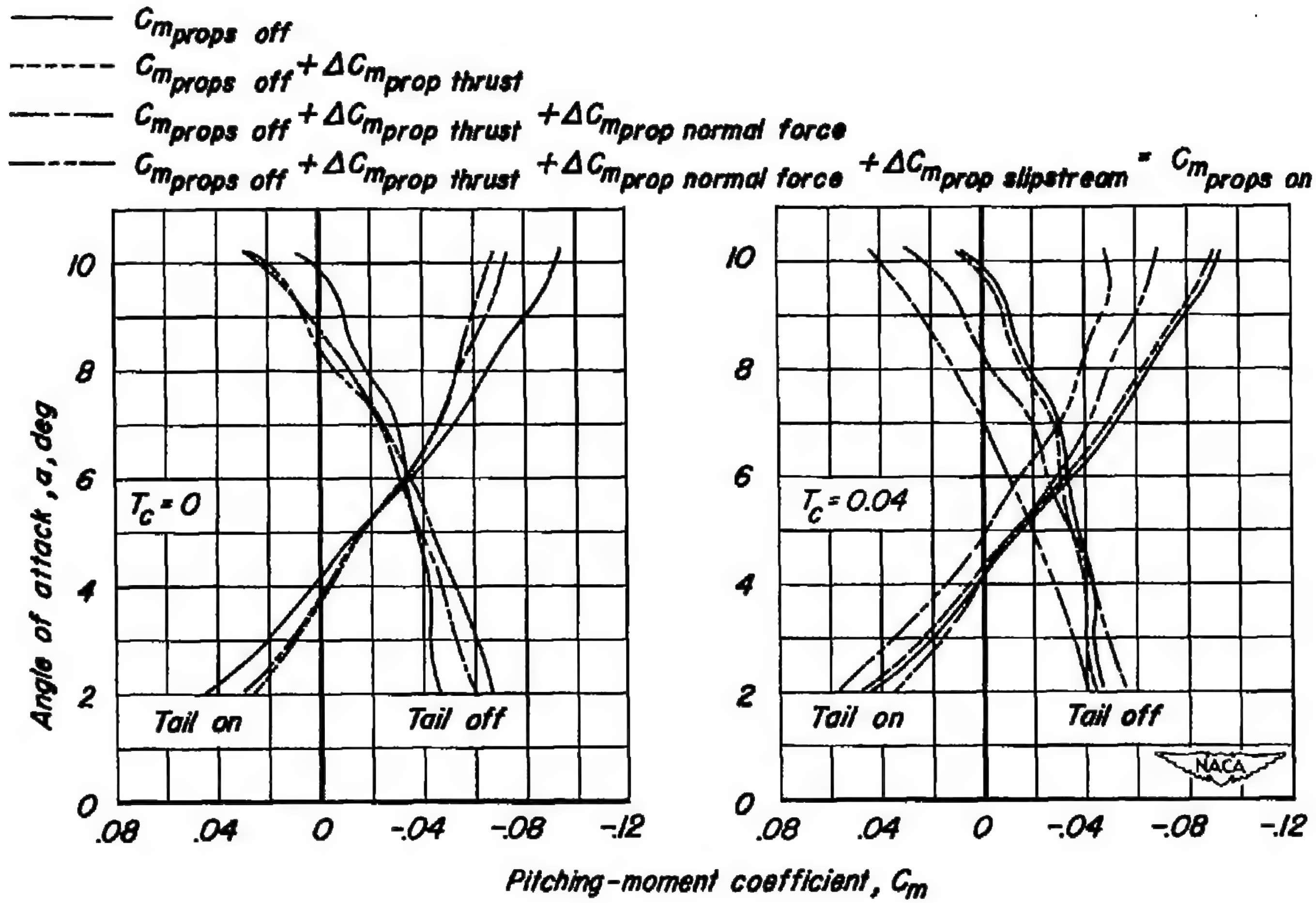
(a) Tail height = 0 b/2, i_t = -4°.

Figure 17.- The effect of Mach number at constant lift coefficient on the pitching-moment-curve slopes of the model with and without operating propellers. β = 51°, R = 1 × 10⁶.



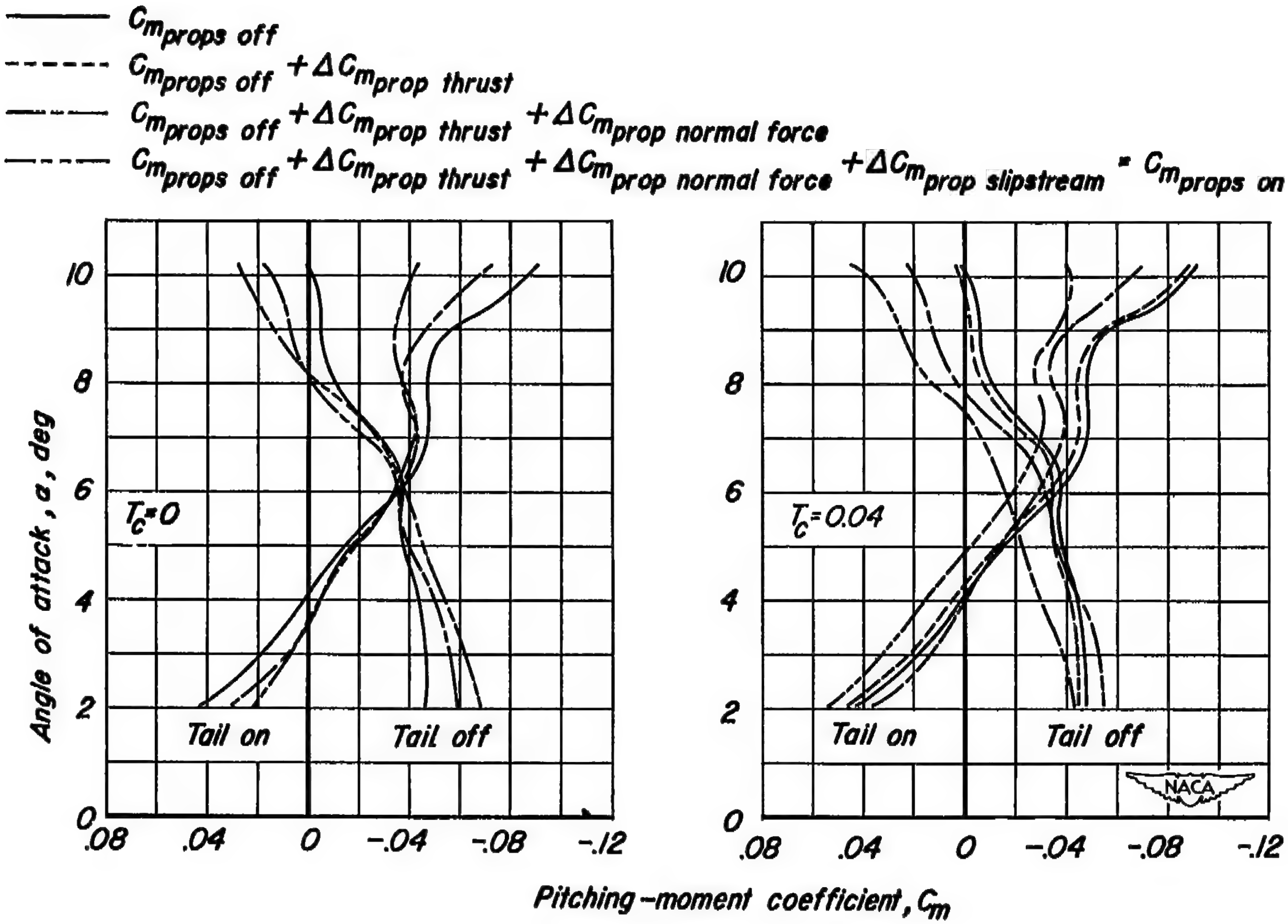
(b) Tail off.

Figure 17.- Concluded.



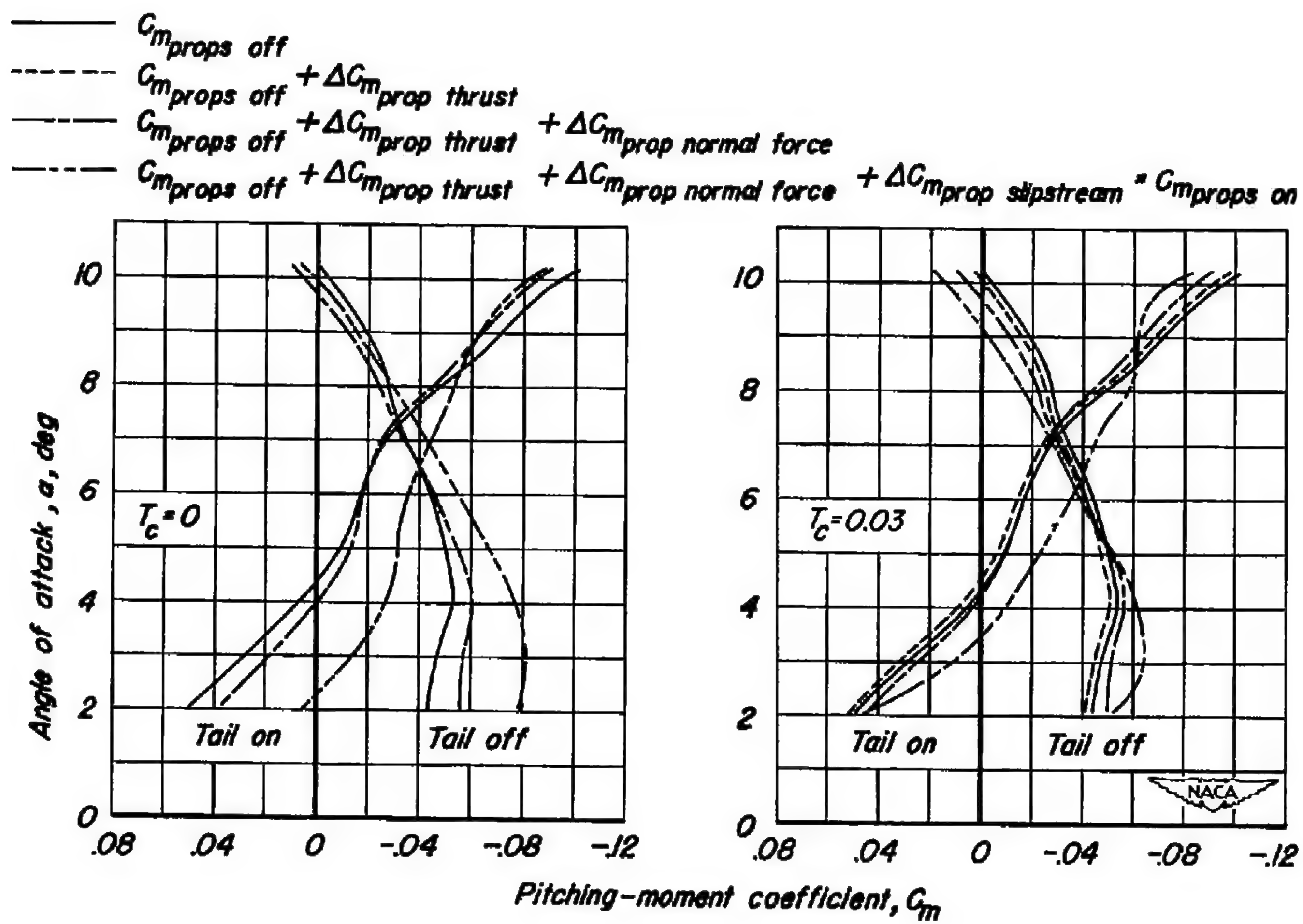
(a) M = 0.70

Figure 18.- The various effects of operating propellers at constant thrust on the pitching-moment characteristics of the model. Tail height = 0 b/2, $i_t = -4^{\circ}$, $\beta = 51^{\circ}$, $R = 1 \times 10^6$.



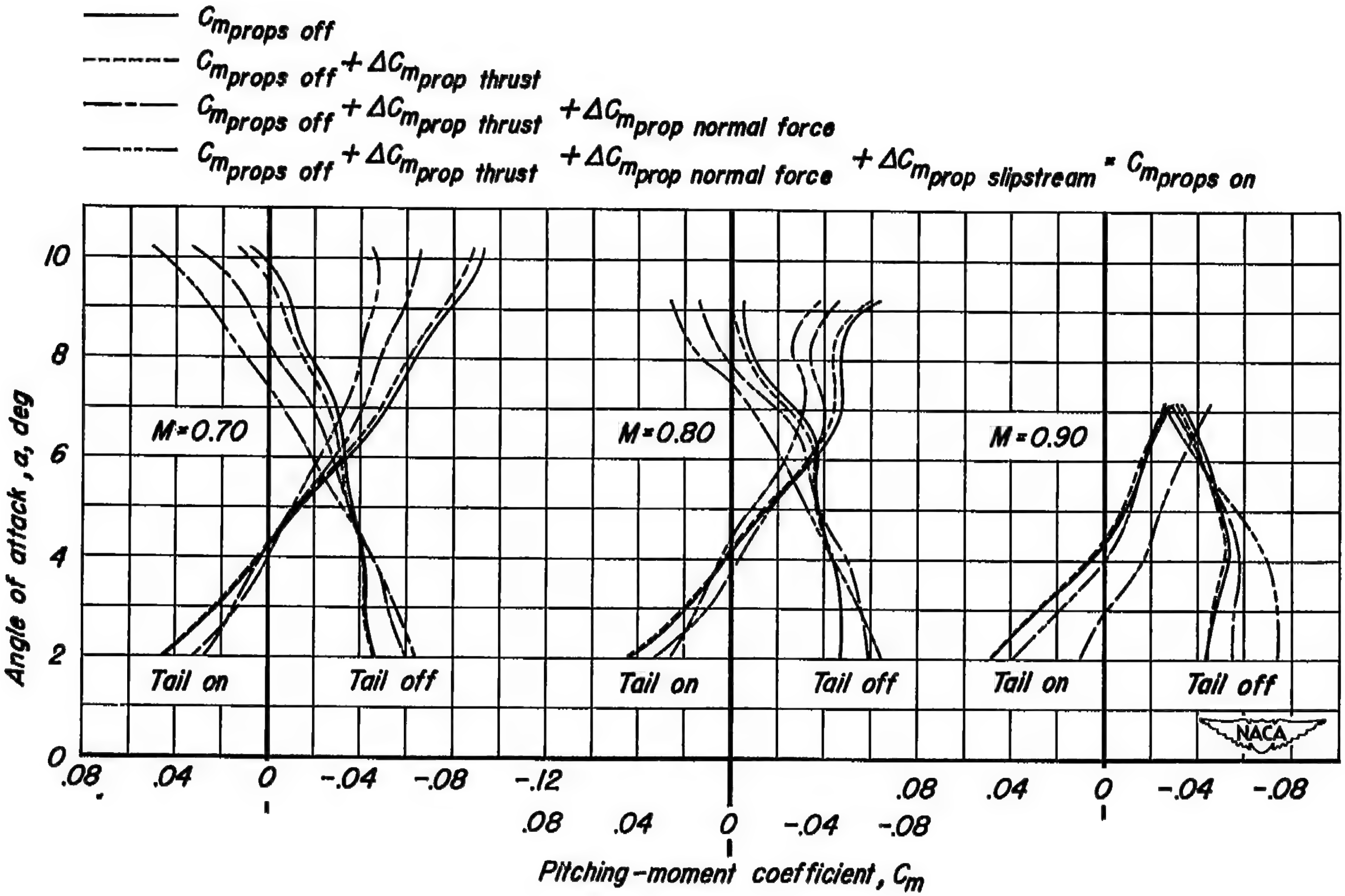
(b) M = 0.80

Figure 18.- Continued.



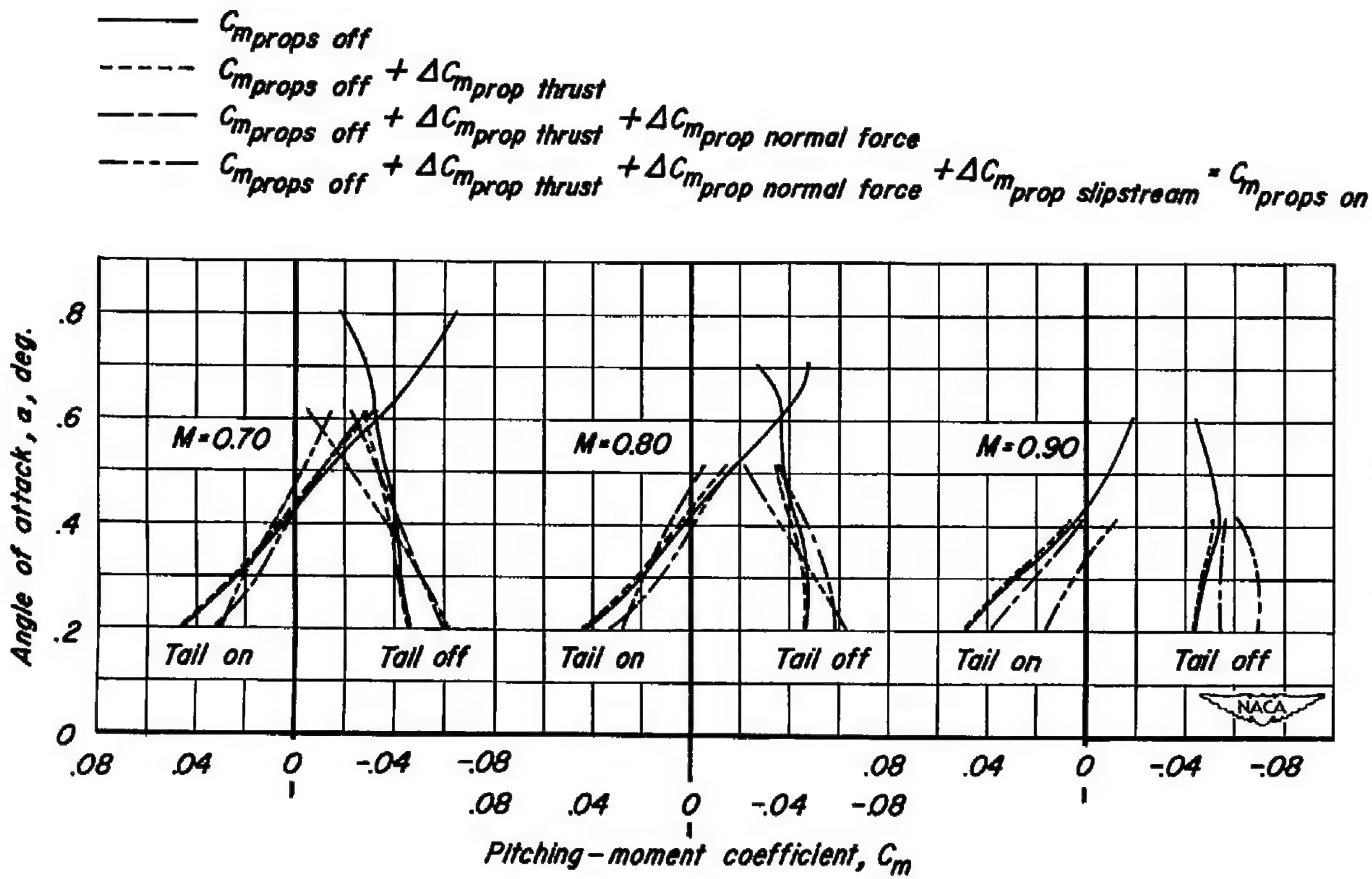
(c) M = 0.90

Figure 18.- Concluded.



(a) 2500 hp per engine.

Figure 19.- The various effects of operating propellers at constant simulated horsepower on the pitching-moment characteristics of the model. Tail height = 0 b/2, $i_t = -4^\circ$, $\beta = 51^\circ$, $R = 1 \times 10^6$.



(b) 5000 hp per engine.

Figure 19.- Concluded.

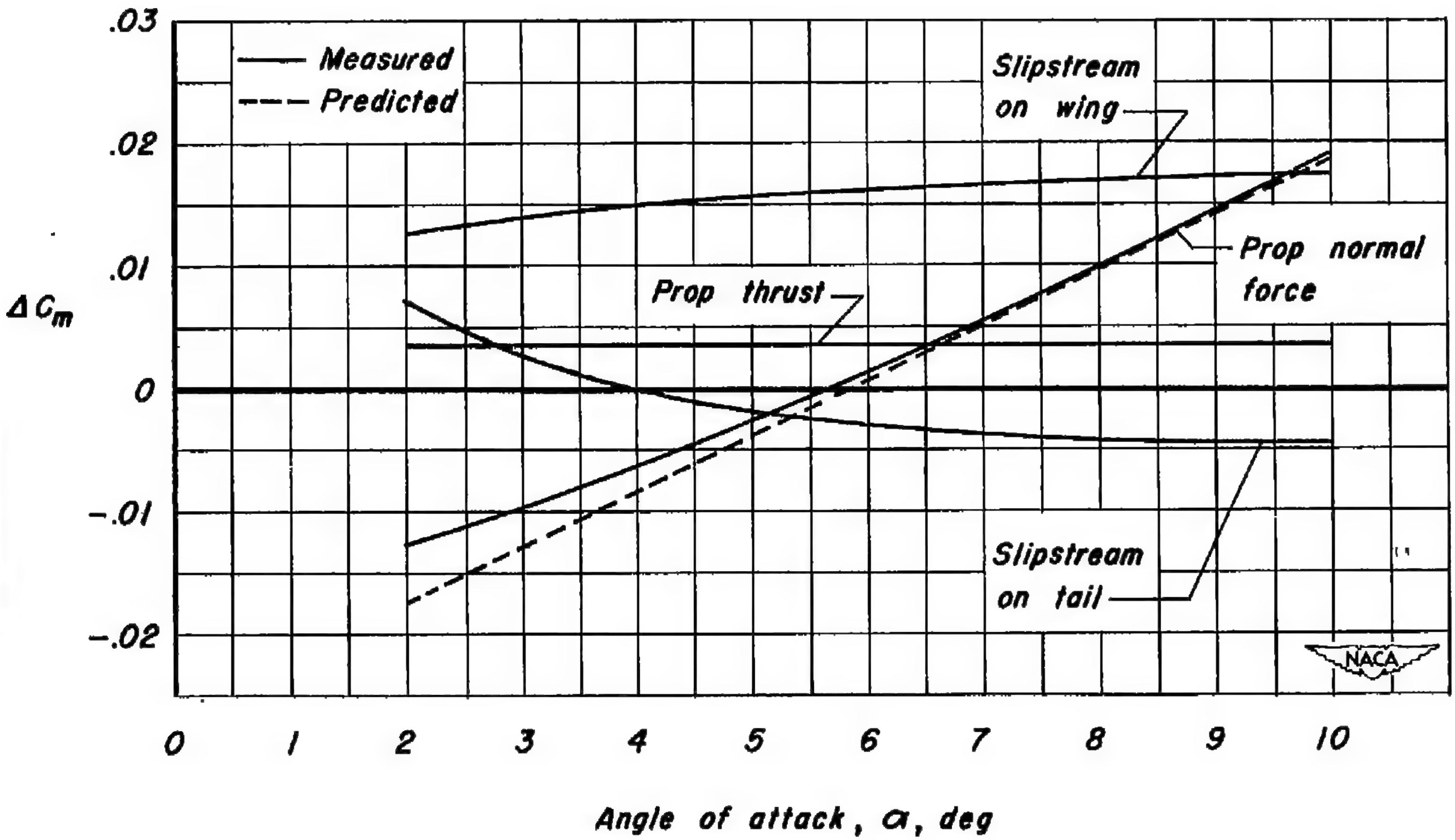


Figure 20.- Comparison of the measured and predicted effects of propeller normal force on increment of pitching moment and the measured effects of propeller thrust and slipstream on increment of pitching moment. $M = 0.80$, $T_c = 0.04$, tail height = 0 b/2, $i_t = -4^\circ$, $\beta = 51^\circ$, $R = 1 \times 10^6$.

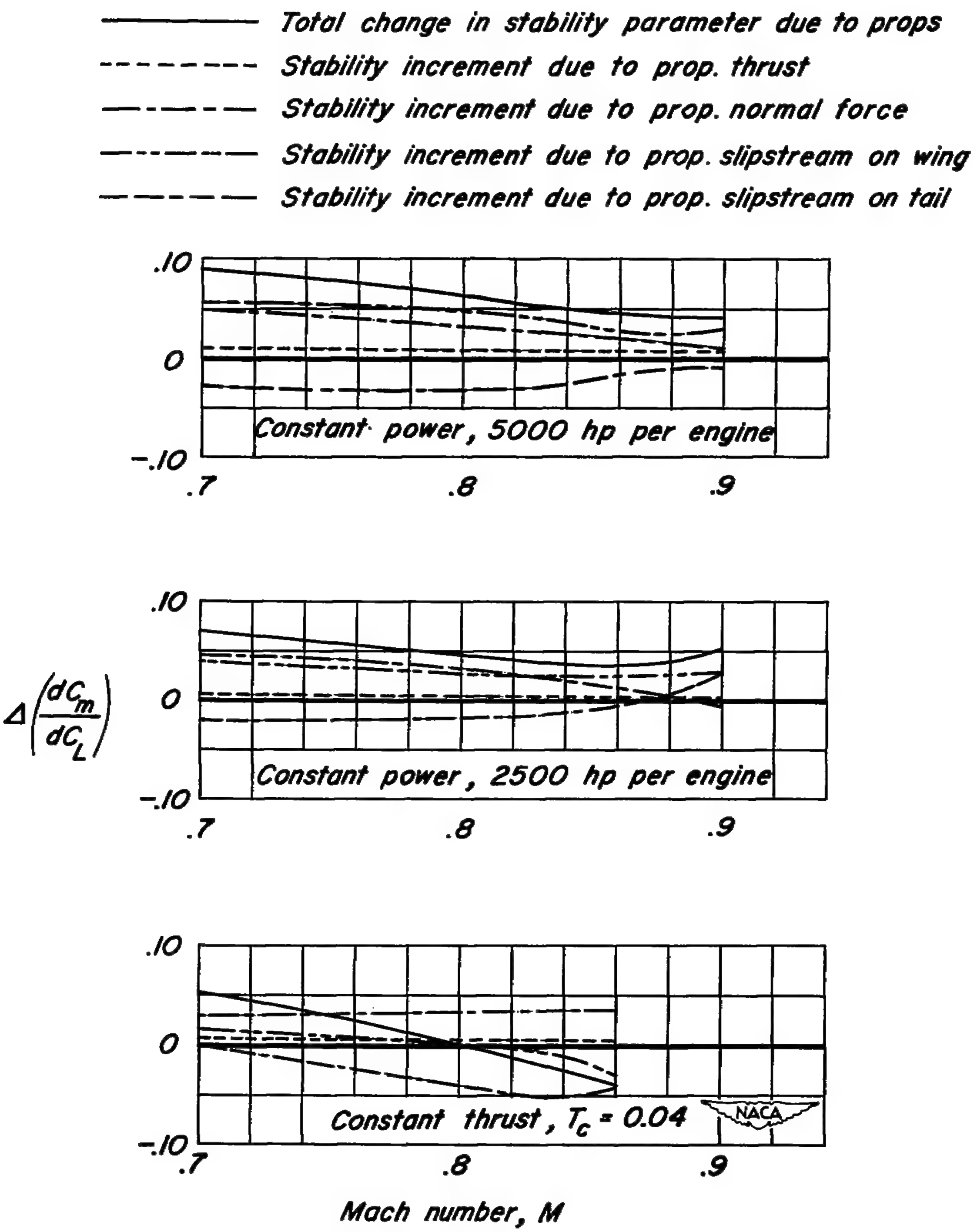


Figure 21.- The variation with Mach number of the various effects of operating propellers on increment of pitching-moment-curve slope. $C_L = 0.40$, tail height = 0 b/2, $i_t = -4^\circ$, $\beta = 51^\circ$, $R = 1 \times 10^6$.

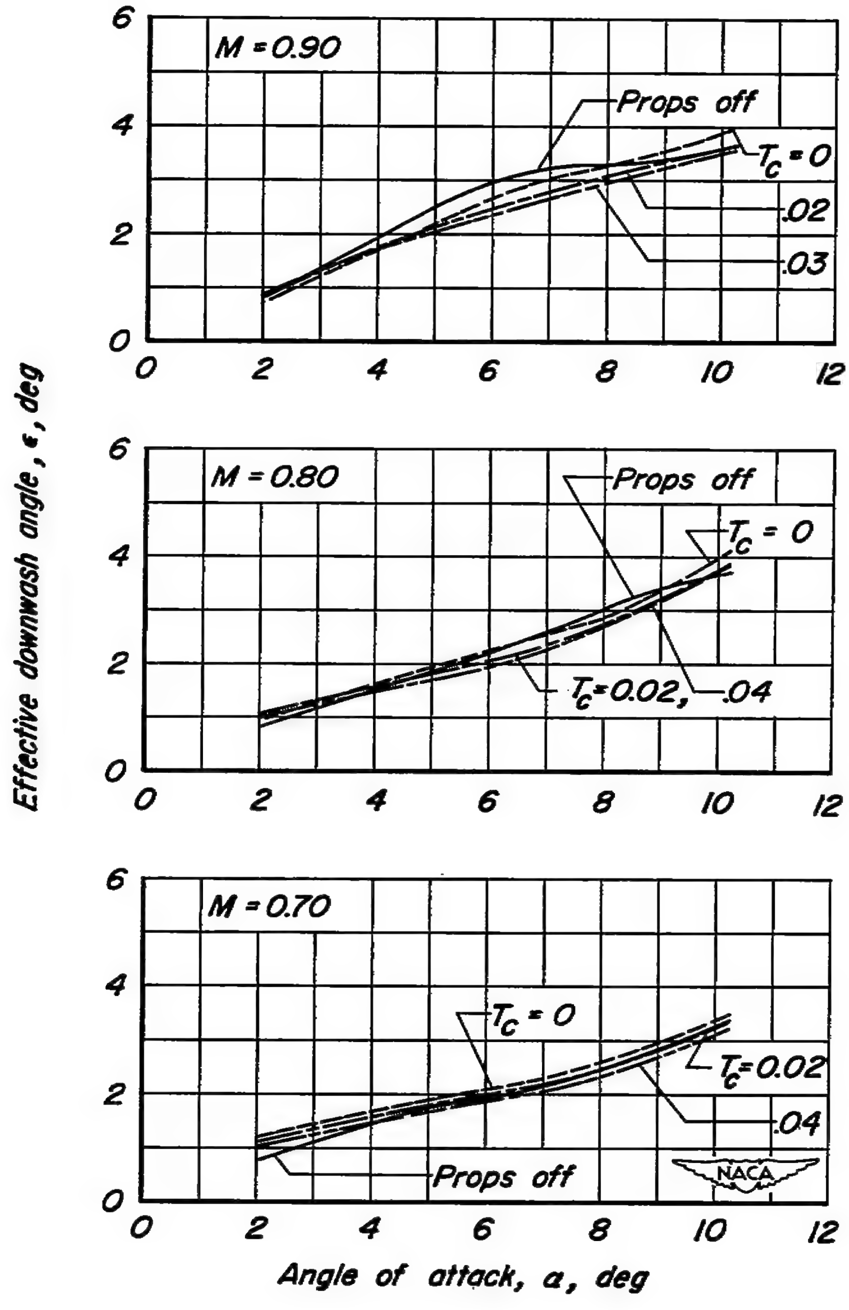


Figure 22.- The effect of operating propellers on the variation of downwash angle with angle of attack. Tail height = 0 b/2, $\beta = 51^{\circ}$, $R = 1 \times 10^{6}$.

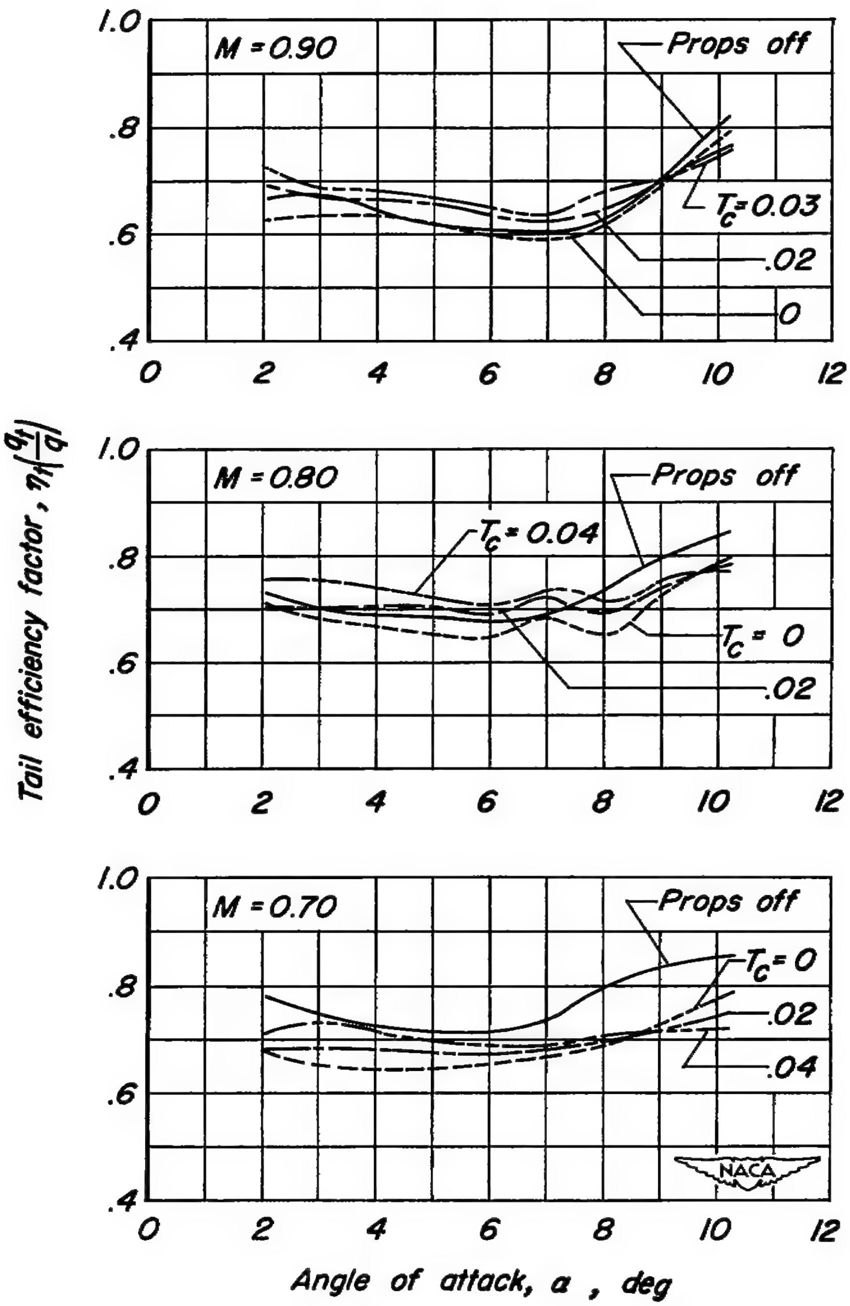


Figure 23.- The effect of operating propellers on the variation of tail-efficiency factor with angle of attack. Tail height = 0 b/2, $\beta = 51^{\circ}$, $R = 1 \times 10^{6}$.

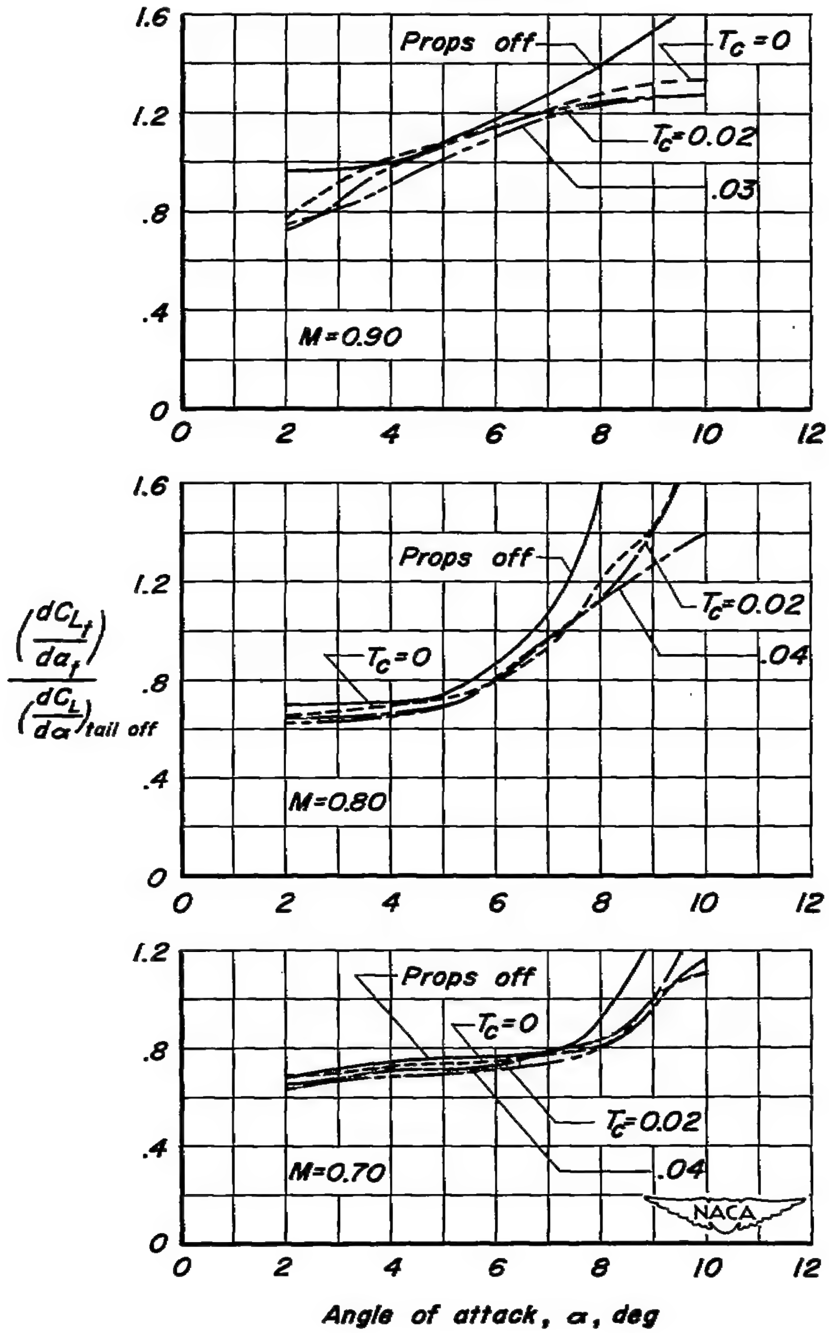


Figure 24.- The effect of operating propellers on the variation with angle of attack of the ratio of isolated horizontal tail lift-curve slope to tail-off lift-curve slope. $\beta = 51^{\circ}$, $R = 1 \times 10^{6}$.

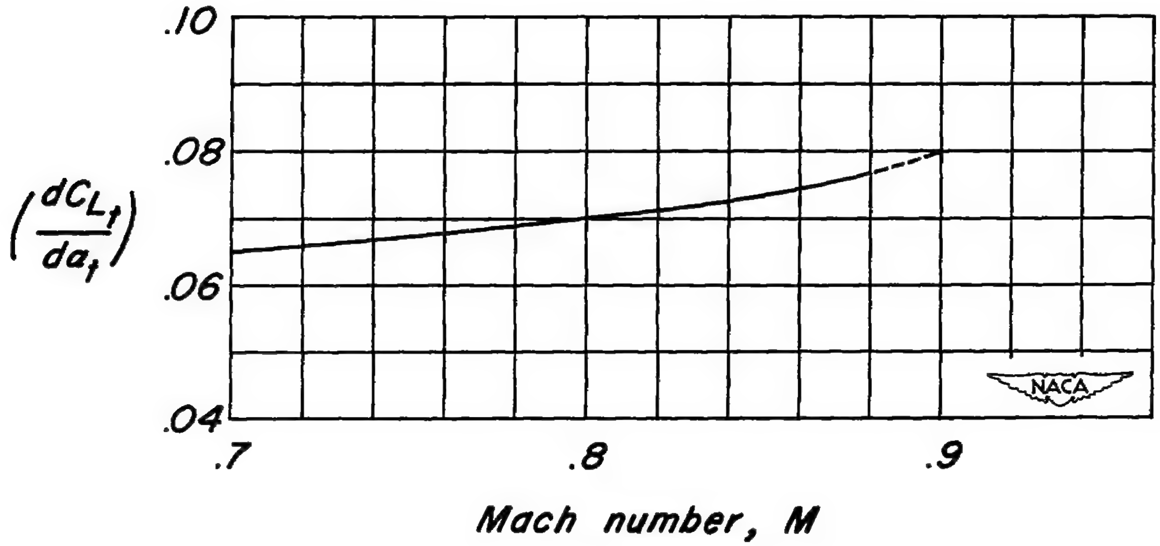


Figure 25.- The effect of Mach number on the lift-curve slope of the isolated horizontal tail. $\alpha_t = 4^\circ$, $R = 2 \times 10^6$.

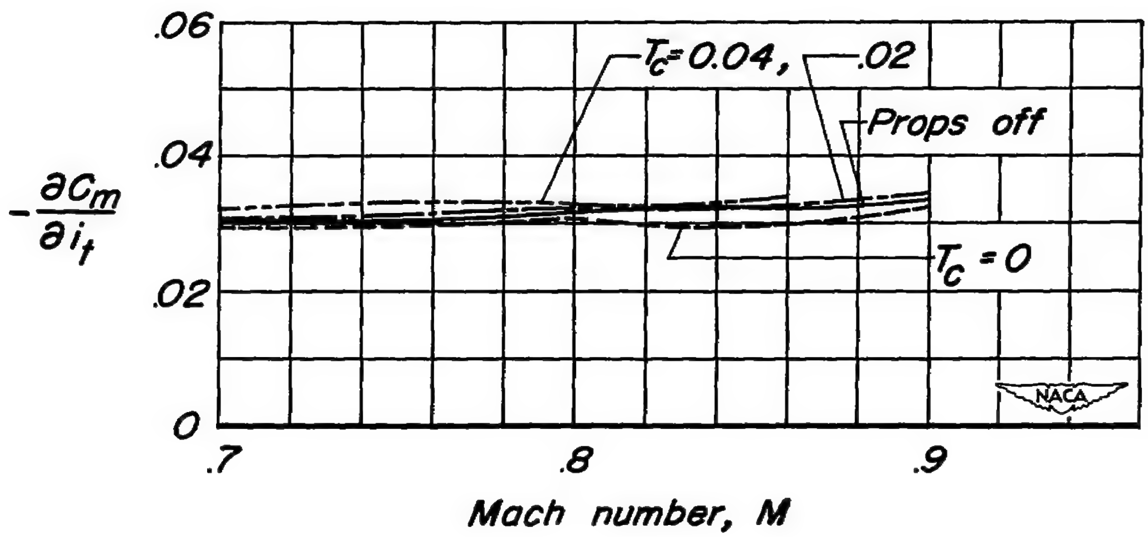


Figure 26.- The effect of Mach number on the effectiveness of the horizontal tail with and without operating propellers. $\alpha = 4^\circ$, tail height = 0 b/2, $\beta = 51^\circ$, $R = 1 \times 10^6$.

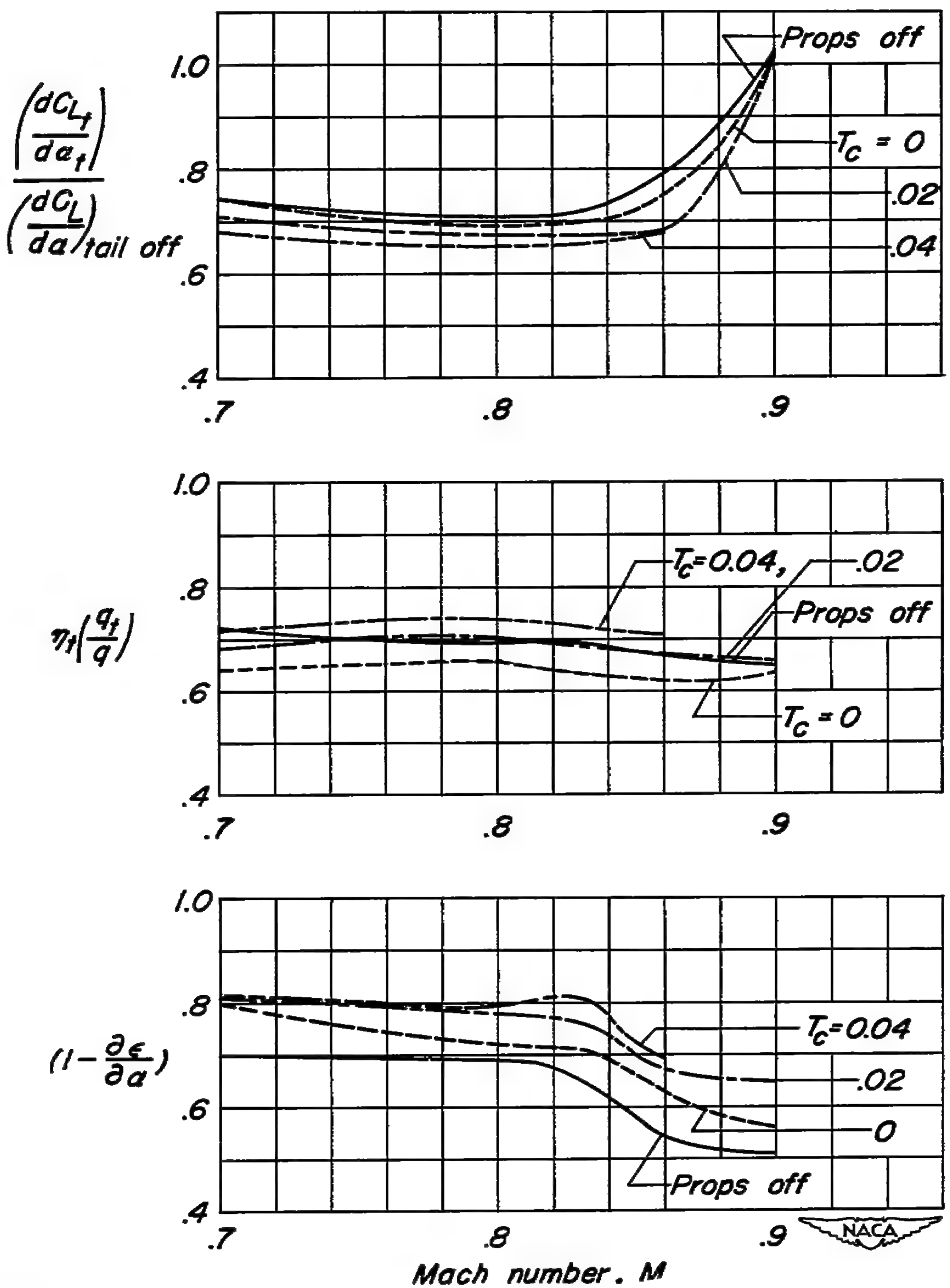


Figure 27.- The variation with Mach number with and without operating propellers of the factors affecting the stability contribution of the horizontal tail. $\alpha = 4^\circ$, tail height = 0 b/2, $\beta = 51^\circ$, $R = 1 \times 10^6$.

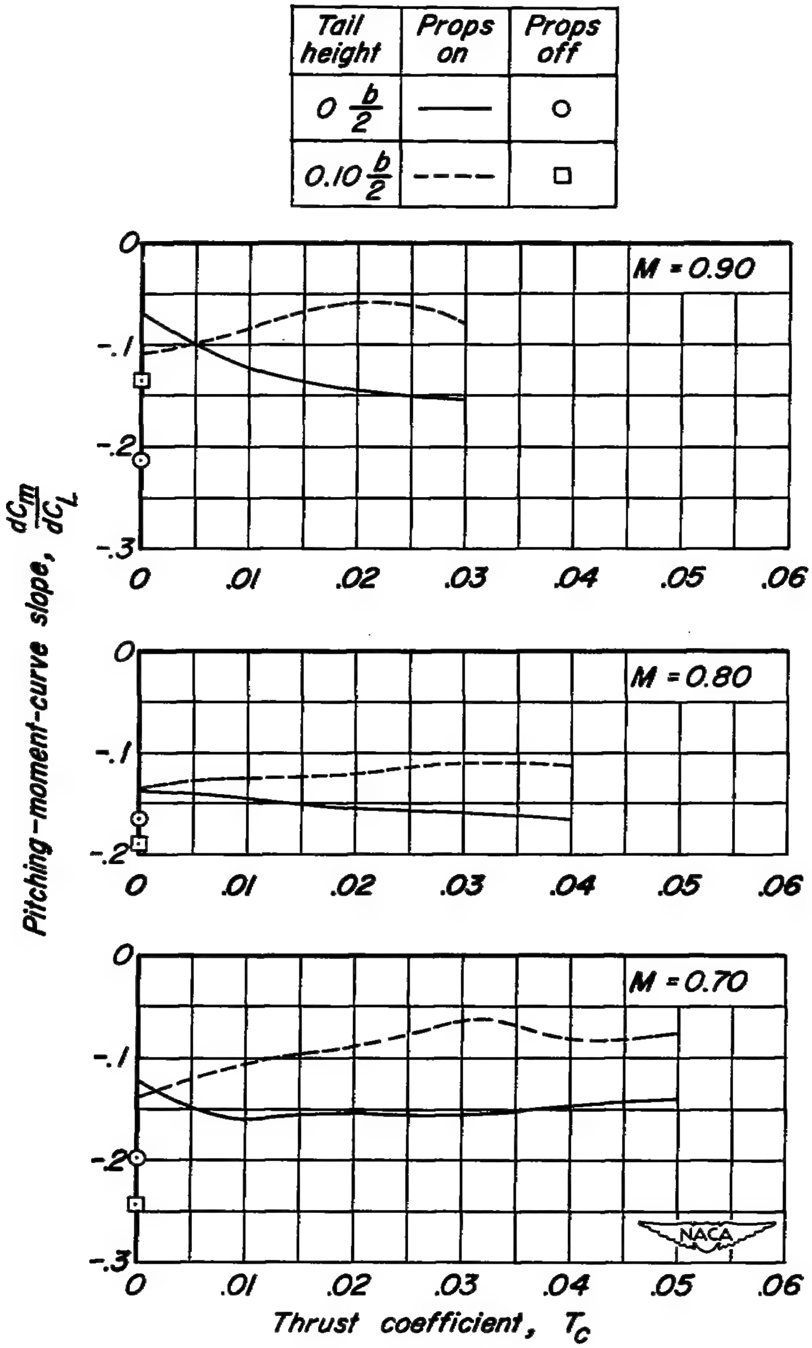


Figure 28.- The effect of horizontal-tail height on the pitching-moment-curve slopes of the model with and without operating propellers. $C_L = 0.40$, $i_t = -4^\circ$, $\beta = 51^\circ$, $R = 1 \times 10^6$.

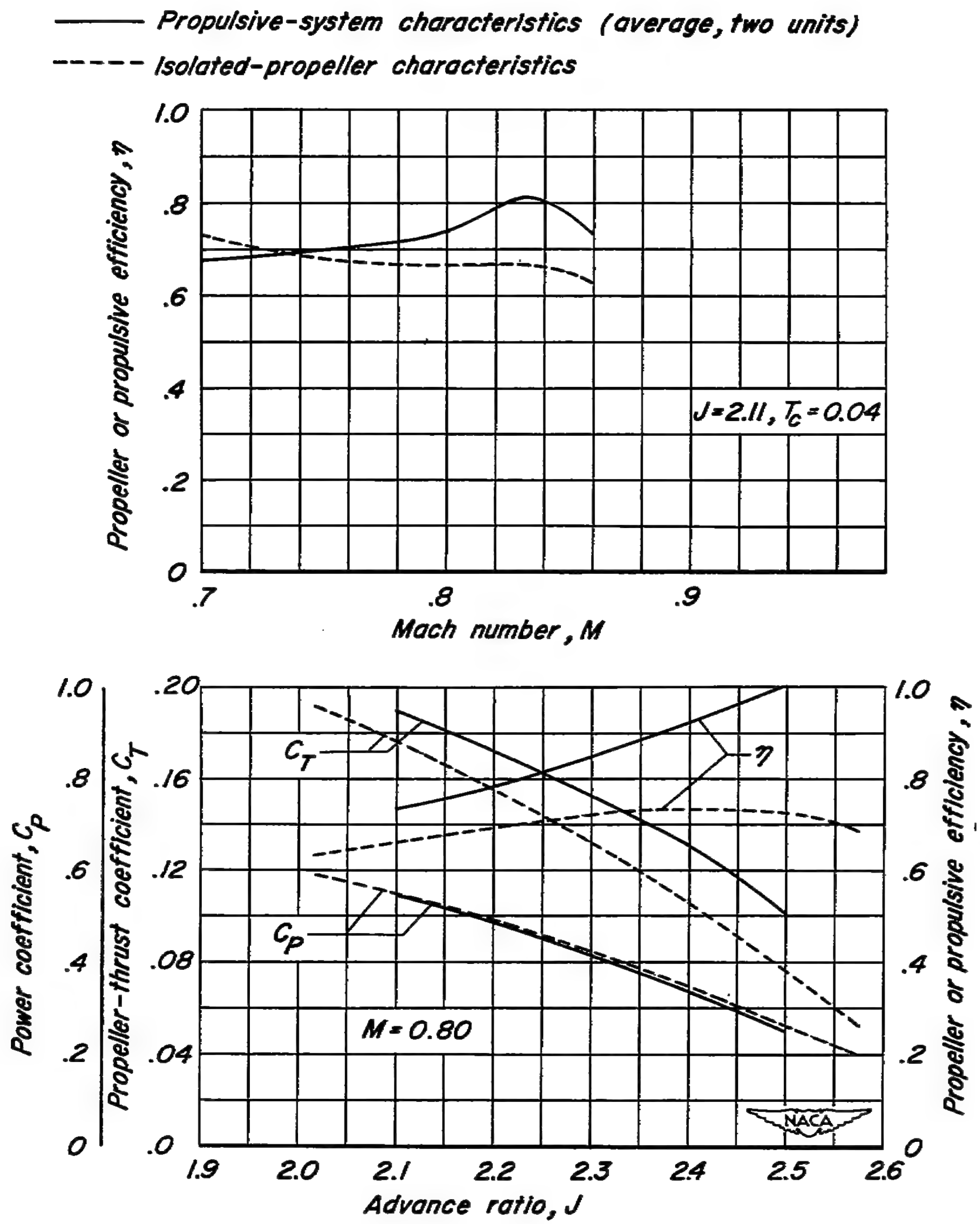


Figure 29.- Comparison of propulsive characteristics with isolated propeller characteristics. $A = 0^{\circ}$, $\beta = 51^{\circ}$, $R = 1 \times 10^{6}$.

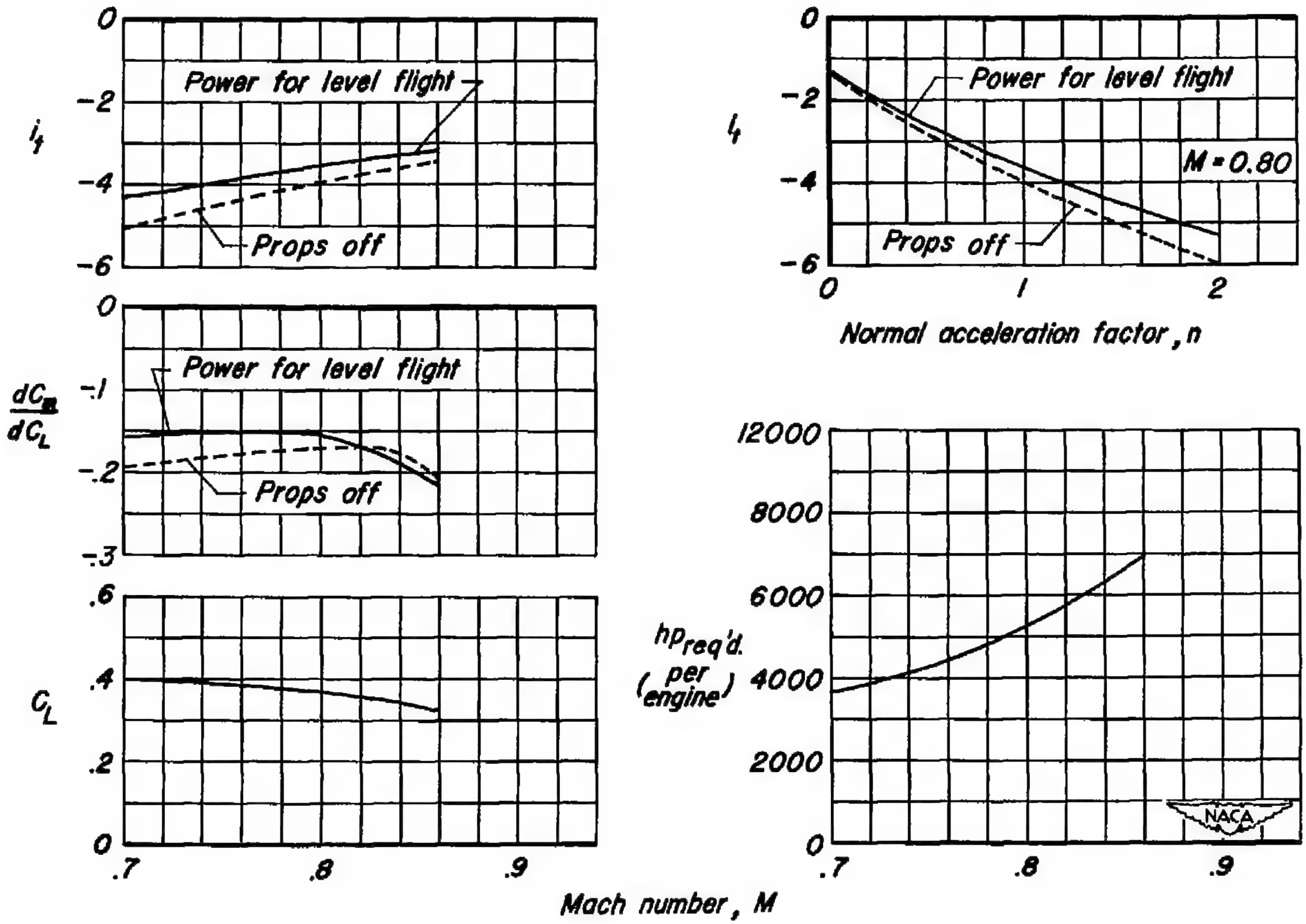
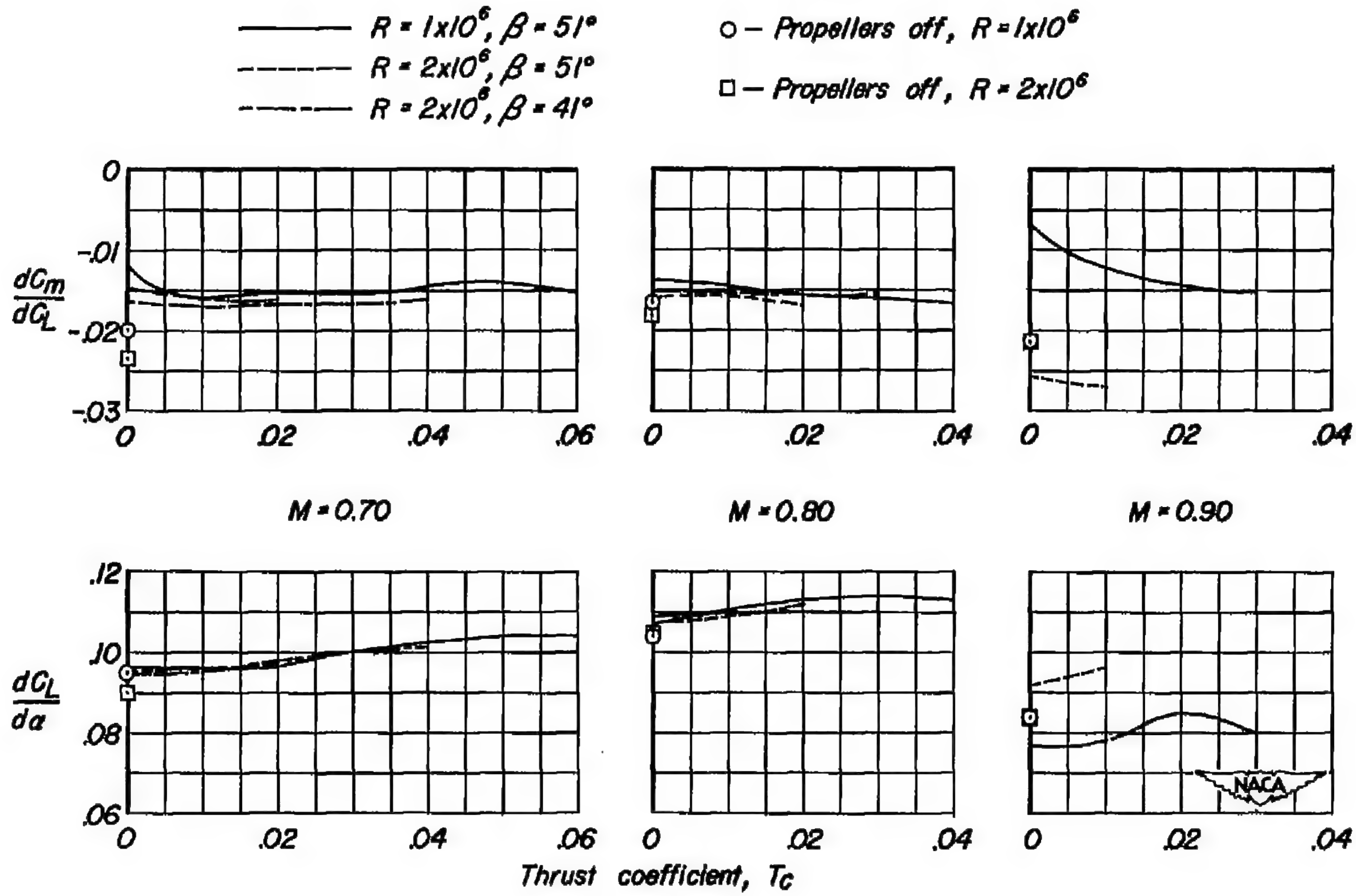
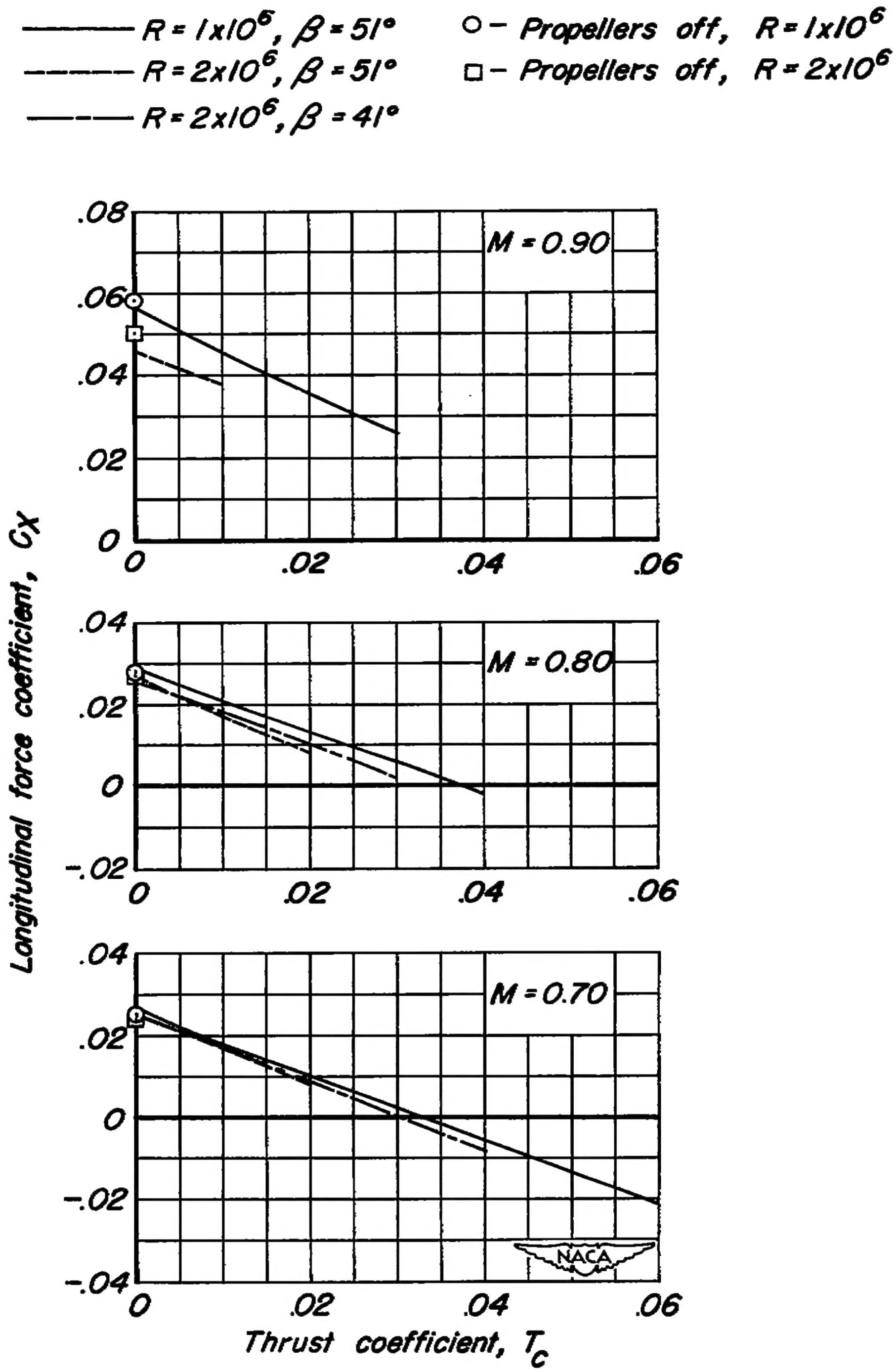


Figure 30.- Summary of the aerodynamic characteristics of a hypothetical four-engine airplane in level flight at 40,000 feet. Tail height = 0 b/2, $\eta_{assumed}$ = 0.65, W/S = 65 lb/sq ft.



(a) Lift-curve and pitching-moment-curve slopes.

Figure 31.- The variation of the longitudinal characteristics of the model with thrust coefficient for two propeller blade angles and Reynolds numbers with and without operating propellers. $C_L = 0.40$, tail height = 0 b/2, $i_t = -4^{\circ}$.



(b) Longitudinal force.

Figure 31.- Concluded.

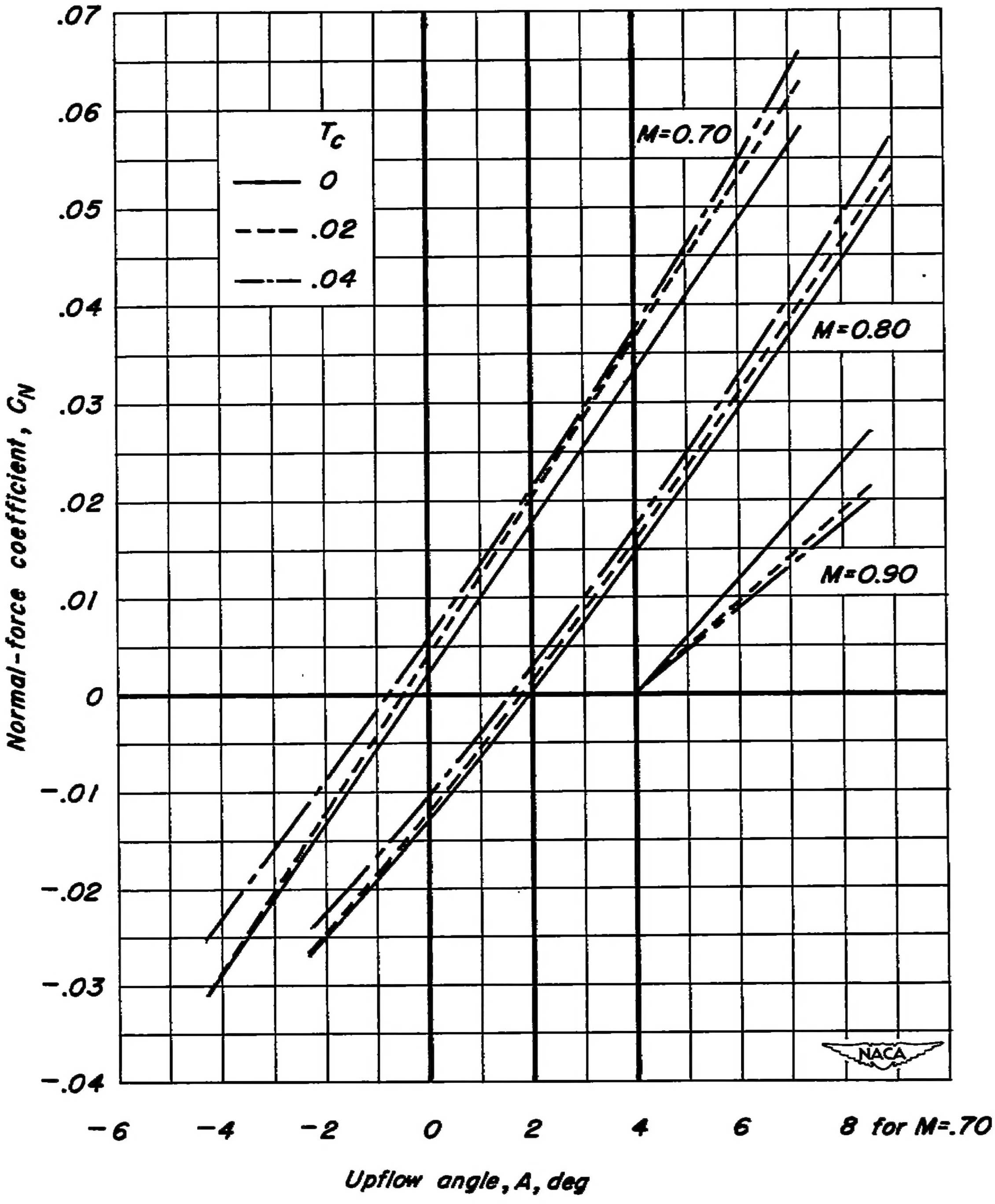


Figure 32.- Normal-force characteristics of the NACA 1.167-(0)(03)-058 propeller. $\beta = 51^{\circ}$, $R = 1 \times 10^{6}$.

[redacted]

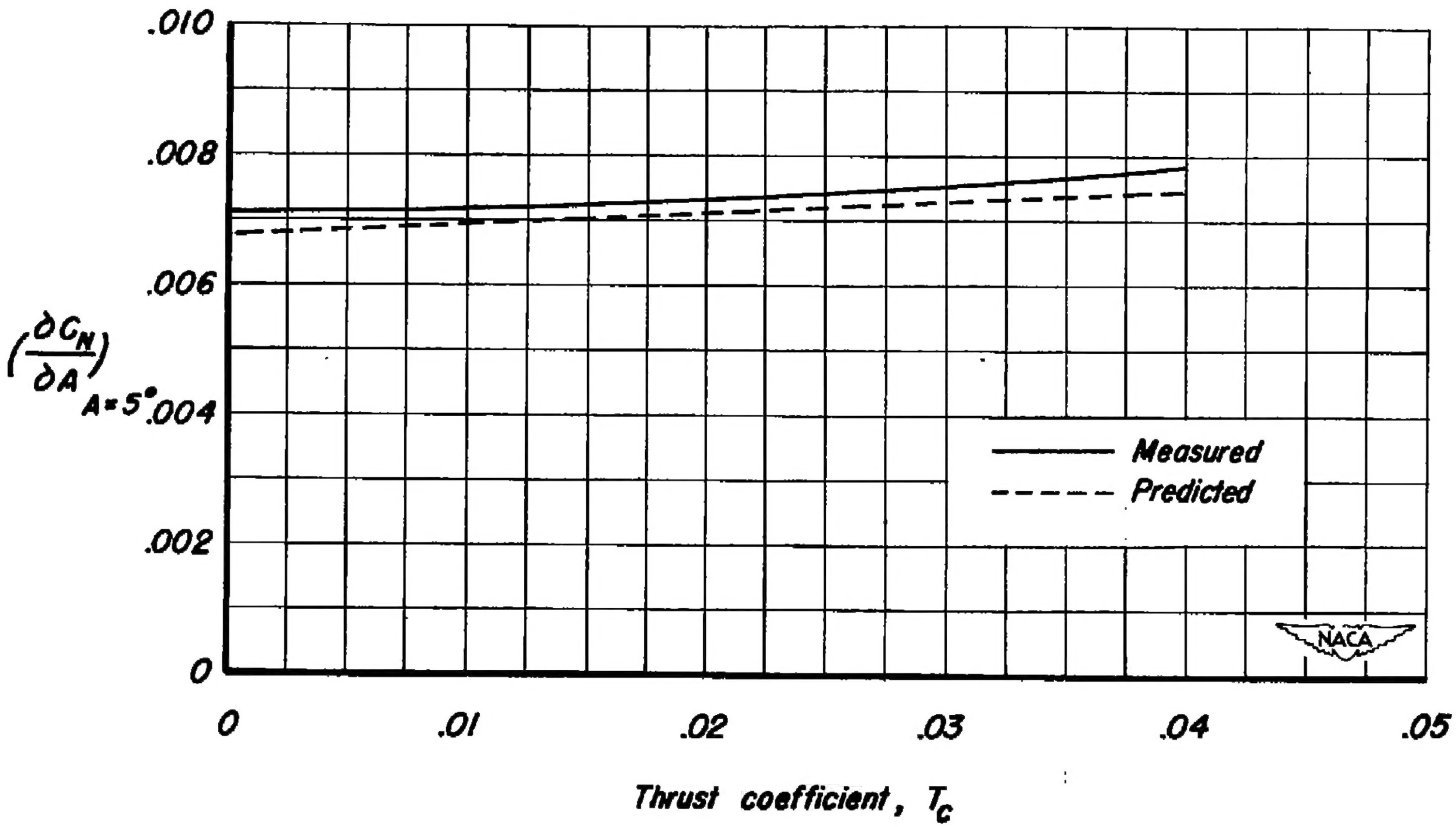


Figure 33.- Comparison of measured and predicted normal-force-curve slopes for the NACA 1.167-(0)(03)-058 propeller. $M = 0.80$, $\beta = 51^\circ$, $R = 1 \times 10^6$.

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